Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

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Abstract

As places that conserve iconic natural heritage, national parks are appropriate destinations for people to engage with and reconnect to nature. Within such parks, the interpretation of the natural science stories behind them is a helpful means to enrich human experience and increase the public's understanding of the natural attractions. Given that effective interpretation includes not only cognitive outcomes but also affective outcomes, photography, as a widely-used tool for documenting science stories and evoking emotions, may help to enhance interpretation. When using a photograph to communicate science stories, it is important to recognise that its efficacy may be affected by its visual characteristics (i.e. subject and visual quality). However, the literature review within this thesis found that to date there is no empirical study on how such visual characteristics influence the effectiveness of photographs for communicating natural science stories.

This thesis was conducted within the context of interpreting natural attractions within national parks. It focused on how photographs with different visual characteristics influence their effectiveness for interpretation from a science communication perspective. Quantitative and qualitative data were collected from May 2017 to October 2018. As the first phase of the research, a survey of the preferences of tourists for a selection of photographs of the natural attractions within the Xixi National Wetland Park (XNWP) in China was designed to identify how the visual characteristics of the photographs influence the preferences of tourists for these photographs. Based on the above results, I then examined the specific role of a few visual attributes of a wildlife photograph in its perceived attractiveness. Next, I focused on the value of photographs with different visual qualities for two widely-used interpretive products: (i) interpretive signage as one of the most common interpretive approaches used in national parks, and (ii) WeChat (i.e. WeChat Public Account articles) as China's most popular online social media application. Tourists' general attitudes towards the importance of photographs for interpretive signage and their responses to the existing interpretive signage within the XNWP were examined firstly as the basis of the subsequent

experiment. Next, using three manipulated signs, I identified the specific contributions of nature photographs for enhancing the effectiveness of the interpretive signage for the purpose of science communication. Lastly, given that interpretive WeChat articles were considered as a potentially powerful tool for interpreting science, a supportive online survey was developed to test the efficacy of nature photographs in WeChat online interpretive articles on natural sciences.

The results of the first section confirmed the relationship between the visual appeal of photographs and the preferences of participants. For the majority of participants, the photograph's visual quality (i.e. aesthetics) was the most important characteristic that determined its perceived attractiveness; those photographs of high visual quality and with a sharp and colourful subject could successfully attract tourists' attention. The subject of a photograph also significantly affected the preferences of observers, which showed an interest-dependent pattern. Using photographs of birds as examples, the participants who were interested in birds tended to be attracted to the photographs of birds rather than those of other subjects. In particular, those bird enthusiasts who have specific knowledge of birds paid more attention to the bird subjects.

The survey on the effectiveness of the existing interpretive signage within the XNWP found that the majority of participants could indeed be attracted to interpretive signage with an appealing photograph. However, the photographs on the existing signage had varied visual qualities, which seemed to affect reading engagement and understanding. Results of the field experiment with manipulated interpretive signage showed that an appealing photograph (determined by its high visual quality) on the signage significantly increased the following affective and cognitive effectiveness of interpretation: (i) visitor's intention to read the signage; (ii) reading engagement; (iii) comprehension and (iv) recall of the information on the signage. Similarly, the survey of WeChat popular science articles noted the perceived visual quality of the photographs used in such articles was related to users' intention to read the article and to their overall engagement.

In summary, this thesis identifies the existing limitations and issues of using photographs as visual elements to interpret natural sciences. Examining widely-used interpretive products (i.e. signage and WeChat) within two Chinese national parks, this thesis offers empirical evidence for the benefits of using high-quality photographs to communicate science. Specifically, it confirms that the use of photographs in interpretive products may not necessarily improve the effectiveness of interpretation, i.e. the visual characteristics of the nature photographs play an important role in the effectiveness of interpretation. Only those photographs with a high visual quality or sharp/colourful subjects are appreciated by observers and as a result enhance affective and cognitive outcomes. This thesis answers the question: what types of photographs are more effective for science communication and how do appealing photographs improve the effectiveness of communication? The results are important both for the selection of photographs within the interpretive product design process and for the evaluation of the effectiveness of such interpretation. This thesis, therefore, has global implications for improving the efficacy of photographs to communicate science, particularly for interpreting natural science stories within national parks.

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Account Name in Chinese: 鸟生

Account ID: birdslife

Field: Wildlife Conservation Communication

Account Name in Chinese: 北美小象君

Account ID: Elephant-Mr

Field: Wildlife Conservation and Animal Welfare

Account Name in Chinese: 鸟医日记

Account ID: birddoctorg

Field: Veterinary Science Communication

Account Name in Chinese: 小叶叔叔的鸟袋

Account ID: xyssdnd

Field: Avian Research Communication

Account Name in Chinese: 北大绿协

Account ID: PKU_GreenLife

Field: Nature Education

Account Name: 在野 Wilder

Account ID: wildericon

Field: Nature Education

Account Name: 野生青年陈老湿的咸盐和碎雨

Account ID: yeshengqingnian

Field: Wildlife Rescue and Conservation

Account Name: 船长的博物方舟

Account ID: natural-ark

Field: Popular Science

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Abbreviations

CBC: Choice-based Conjoint (Analysis)

GB: Participants who have a general interest in birds but do not have much experience and knowledge of birds

GN: Participants who have a general interest in nature and biology but do not have much relevant experience and knowledge

NB: Participants who are not interested in birds

NN: Participants who are not interested in nature and biology

SB: Participants who have a specialised interest in birds, with specific experience and knowledge of birds (e.g. bird watchers).

SN: Participants who have a specialised interest in nature and biology, with specific experience and knowledge in the relevant fields.

XNWP: Xixi National Wetland Park (Zhejiang Province, China)

XRNP: Xishuangbanna Rainforest National Park (Yunnan Province, China)

Chapter 1. Introduction

1.1. National parks: connecting nature and people

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Why is science communication within a national park important?

Does photography help to enhance science communication?

If so, what type of photographs are the most effective for interpreting science stories within the parks?

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With significant natural and cultural heritage being protected by national parks, these are attractive destinations for tourists (Hvenegaard & Dearden 1998; Hwang et al. 2005). Even though there are a variety of reasons given by tourists for visiting a national park, there is an almost universal consensus that connecting with nature (e.g. nature excursions, biodiversity encounters and education) is one of the most vital motivations to visit such parks (Van der Merwe & Saayman 2008). Given that most park visitors are not nature specialists (Akama & Kieti 2003; Arabatzis & Grigoroudis 2010; Scholtz et al. 2013), the interpretation of local natural attractions plays, therefore, an important role in enabling visitors to enrich their experience of national parks and increase their understanding of nature (Tubb 2003; Department of Conservation 2005).

Within national parks or, indeed, similarly protected areas, interpretation is defined as "an explanation of the natural, cultural or historic values attached to places" (Department of Conservation 2005). Here, nature interpretation can be considered as science communication about such subjects as biodiversity, ecology and conservation (Tilden 2009). The effective interpretation of nature stories enables visitors to gain interests, understanding and awareness of local natural attractions in an enjoyable way (Department of Conservation 2005;

Ismail 2008). The potential effectiveness of such interpretation closely aligns with the general outcomes of science communication: affective outcomes, cognitive outcomes and behavioural outcomes (Burns et al. 2003; Ham & Weiler 2006). The potential benefits of discussing nature interpretation from a science communication perspective include: (i) understanding and increasing the effectiveness of interpretation through mixed methods that involve the science, media and audience being involved, and (ii) exploring visitors' interests, attitudes, and levels of knowledge more systematically when looking at the effectiveness of nature interpretation (Burns et al. 2003).

Successful science communication includes not only increases in knowledge and awareness but also positive emotional responses (e.g. attention, enjoyment and interest) evoked during the communication process (Burns et al. 2003). Photography, as a widely-used means to visualise science and evoke emotions (Houts et al. 2006; Carr 2012), could be a potentially powerful tool to communicate nature stories more effectively (Joseph 2013; Husain et al. 2017). However, even though the use of images in science communication has been proven to help to attract an audience's attention (Redi & Povoa 2013), increase their enjoyment (Levie 1987), comprehension and information remember/recall (Austin et al. 1995), and even though the use of imagery is widespread in interpretative products (e.g. signage) in national parks (Department of Conservation 2005; Province of Nova Scotia 2008; Dandan 2012), there has been no research or empirical evidence to measure the contribution that photographs make to nature interpretation in national parks. To clarify the potential role of photographs in such interpretive products and to improve the efficacy of using photographs, this thesis focused on how photography can influence the effectiveness of science communication (i.e. nature interpretation) through interpretive products within national parks.

When modelling whether and how photography enhances science communication, the visual characteristics of photographs need to be considered (Frankel 2001; Husain et al. 2017). Given that the visual characteristics of a photograph may significantly influence its visual appeal and an observer's emotional responses (Slykhuis et al. 2005; Redi & Povoa 2013),

integrating visually appealing photographs into the interpretive products in national parks may well have positive implications for the effectiveness of nature interpretation. However, there is a lack of research on what types of nature photographs, in term of their visual characteristics, are attractive to park visitors. Additionally, because evaluating the effectiveness of imagery for communication is complex and involves multiple disciplines (Burns et al. 2003; Ham & Weiler 2006; Ren & Folta 2016), there is no existing study on how different photographs might affect the communication of science stories through interpretive products. Until now, researchers have focused on: (i) individuals' preferences for different types of photographs, including nature/wildlife photographs (Landová et al. 2012), (ii) general discussions on the potential use of photography for science and conservation communication (Frankel 2001; Joseph 2013; Husain et al. 2017), and (iii) how images, including photographs, increase the efficacy of communicating about science stories within different disciplines (e.g. health and mathematics communication) (Betts & McNaughton 2003; Houts et al. 2006).

This research project is designed to extend the studies above by specifically looking at the potential benefits of using photographs in nature interpretation. From a science communication perspective, I aimed to investigate how photographic images can enhance nature interpretation within national parks. With different types of nature photographs being involved, it attempts to clarify: (i) the specific role of photographs for science communication within national parks, and (ii) how the visual characteristics of photographs can affect the efficacy of science communication with the context of two selected interpretive products: the interpretive signage and WeChat interpretive articles. It should be noted that even though images include not only photographs but also other types of pictures (e.g. painting, drawing, computer-generated pictures *etc.*) (Lopes 1996), the operational definition of "image" in this thesis, particularly in data chapters, refers to photographs only, because the focus of this thesis was the efficacy of photographs for science communication.

1.2. Outline of the thesis

This thesis starts with a general introduction chapter (Chapter 1), including the following research background: (i) the concept of nature interpretation within the national parks, (ii) why I consider nature interpretation as science communication, and (iii) why photography is suggested as an important aspect to enhance nature interpretation. The background section is followed by a brief description of prior studies in the fields of photography, national park and science communication, revealing the relevant research gaps and opportunities. This chapter also includes an outline showing the structure of the thesis.

Within the context of national parks in China, the second chapter presents a literature review on the potential of using imagery to enhance interpretation of science stories about nature. It starts with descriptions of the concept of national parks and nature interpretation in such parks. Next, it discusses the significance of using photographs in interpretive materials, followed by an explanation for the importance of photographs' visual characteristics. It also presents introductions to the two selected interpretive products that are the focuses of this thesis (signage and WeChat) and the reason for selecting them. It finishes with a description of the specific research questions and design.

Chapters 3 to 7 present the specific aims, methodologies, results and discussions of this study, which includes three main sections. First, Chapter 3 and Chapter 4 investigate how the visual characteristics of nature photographs can affect a visitor's preference within national parks. Specifically, Chapter 3 focuses on the influences from visual qualities and different types of subjects of a photograph, while Chapter 4 examines the implications of specific visual attributes (e.g. sharpness and colourfulness of the subject) for the perceived attractiveness of a photograph. Second, within the context of the existing interpretive signage (Chapter 5) and manipulated interpretive signage (Chapter 6) in a Chinese national park, I explored how the presence and characteristics of nature photographs influence the effectiveness of interpretive signage for science communication. Third, the potential role of photographs for an online interpretive product: WeChat Public Account is investigated in Chapter 7.

The last chapter of this thesis presents an overall discussion and conclusions (Chapter 8). It summarises and interprets the main findings of the project in light of the research objectives. The specific roles of photographs for nature interpretation are clarified and discussed. Limitations and potential further developments are also given before finishing with the overall implications and contributions of this project.

Chapter 2. Interpreting Natural Attractions within National Parks: The Role of Photographs

2.1. Introduction

An increasing number of people are disconnected from nature due to the global urbanisation and our modern lifestyles (Soga & Gaston 2016), resulting in a lack of nature literacy and support for conservation (Forestell 1993; Tisdell & Wilson 2004; Giusti et al. 2018). Communication of science and nature stories are needed to increase public understanding of nature and conservation (Tisdell & Wilson 2004; Glikman et al. 2012). With a range of iconic natural or cultural heritage protected within their boundaries, national parks are considered appropriate areas to communicate science and reconnect people with nature (Boza 1993; Butler & Boyd 2000). However, just visiting a national park may not necessarily increase the public's understanding of nature and conservation (Zaradic et al. 2009). Nature interpretation is required to visualise and communicate the nature stories within the park and thereby enable visitors to obtain knowledge in an enjoyable and effective way (Department of Conservation 2005; Hughes & Morrison-Saunders 2005; Ham & Weiler 2006).

This chapter starts with an introduction to the concept of national parks and the interpretation of nature within those parks, especially in relation to China. Next, from the perspectives of tourism and conservation, it explains why nature interpretation is important for national parks and why such interpretation can be considered as science communication. It then presents what is needed to enhance the effectiveness of communication through interpretative products within the parks. Based on the requirements above, it explains the potential of enhancing science communication by using photographs. It then explains why visual characteristics of photographs should be considered when integrating them into interpretive products, followed by an introduction of the existing means of assessing such visual characteristics. Lastly, it describes two specific interpretive products that are used in this thesis: interpretive signage within the park and interpretive articles produced by WeChat

(a social network mobile application). Within the context of these two products, this project tests the role of photographs in communicating about science stories by mixed methodologies in the following chapters.

2.2. A need for exposure to nature

Covering a wide range of habitats from cold-temperate zone to tropical, China is one of the most biodiverse countries in the world (López-Pujol et al. 2006; Hu et al. 2017). However, due to a variety of factors (e.g. increasing population, urbanisation and commercial exploration), many conservation problems have arisen and must be faced by society (Curtis et al. 2012). Hu et al. (2017) mapped the distribution ranges of threatened bird species to identify potential conservation hotspots in China and found these hotspots significantly overlapped with the fastest-developing regions. Such findings suggest that understanding and support from the general public are becoming increasingly necessary to help avert a conservation crisis caused by the rapid population growth in these areas (Miller 2004; Hu et al. 2017).

However, a diminished human-nature connection is identified as a global issue that hinders conservation communication, especially in those fastest-developing areas (Forestell 1993; Zaradic et al. 2009; Giusti et al. 2018), which discourages individuals' positive emotions and attitudes with regard to biodiversity and environment (Soga & Gaston 2016). To resolve this problem, Kals et al. (1999) suggested that nature exposure is an effective means to reconnect human and nature, which not only delivers a positive emotional affinity towards nature but also potentially increases people's understanding of nature (Forestell 1993; Ballantyne et al. 2011).

Nature exposure includes outdoor activities within a range of natural destinations such as national parks, regional parks and other wilderness/protected areas (Zaradic et al. 2009; Soga & Gaston 2016). Here, "natural destinations" refers to those areas with relatively rich geological and/or biological diversity (Ducarme & Couvet 2020). Amongst these areas, a

national park has national or even global significance (Tubb 2003; Ismail 2008; National Park Service 2016) because: (i) individuals have opportunities to encounter a variety of unique or vulnerable natural attractions within a national park (IUCN 1980; Department of Conservation 2018) and (ii) such a park is managed by the relevant departments of a nation, which ensures a higher standard of the services and facilities within the park than those in regular parks and other wilderness areas (Rui 2001; Akama & Kieti 2003). This is also confirmed by a few existing studies on tourists' motivations for visiting national parks: nature encounters are one of the most important factors motivating them to visit national parks (Wu et al. 2004; Van der Merwe & Saayman 2008).

For national parks that attract many visitors to encounter nature, interpretation plays a significant role in the visitors' local experience (Department of Conservation 2005; Hwang et al. 2005). Even though most tourists within a national park are not nature experts, they are still able to increase their understanding of local biodiversity, environment and landscape through interpretation (Hughes & Morrison-Saunders 2005; Ismail 2008; Ballantyne et al. 2011; Hvenegaard 2017). It has been suggested that if visitors are educated and exposed to effective interpretation within a national park, both tourism and conservation will benefit from each other (Butler & Boyd 2000). The next section describes the definition and functions of a national park and will give an overview of nature interpretation within such parks.

2.3. Communicating about science stories within national parks

2.3.1. The concept of a national park

In 1872, Yellowstone National Park, which contains unique landscapes and wildlife diversity, was established as the first national park in the world, some thirty-one years after the concept of "National Park" was first proposed by Catlin (1841). Typically, a national park is a type of protected area that covers unique, representative or vulnerable natural attractions and/or significant cultural heritage, managed by a national authority (IUCN 1980; National Park

Service 2016; Wikipedia 2017; Department of Conservation 2018). "*National parks are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities*." This definition had been firstly approved by the 10th General Assembly of the International Union for Conservation of Nature and Natural Resources in 1969 before it was adopted by the Second World Conference on National Parks (IUCN 1980; Dudley 2008). This definition emphasises the value of national parks in term of conservation and tourism. Along with the development of national parks, most countries and organisations have indeed found that national parks can preserve the natural attractions from the environmental degradation caused by urbanisation or other human exploitations (West & Brechin 1991; Gülez 1992).

By 2018, the concept of the national park had been accepted and applied in 122 countries (Wikipedia 2018), resulting in a significant increase in the amount and area of land preserved as national parks. For example, a total of 409 sites (covering 342,430.11km^2), including fifty-nine national parks and 350 other types of reserves and natural heritage, had been included in the national park system of the United States by 2016 (National Park Service 2016). However, in China, the exact definition of the national park remains controversial, resulting in a complex national park system, which is described by Wikipedia's page on the list of protected areas in China (Wikipedia 2017).

2.3.2. The Chinese national park system

The national park is not a new concept for China, but the Chinese national parks system is still complicated and unclear. Chinese national parks are divided into a variety of categories, and are managed by different competent authorities (Chen & Xu 2006; Mu & Li 2007; Maozhu et al. 2009). For example, there are eleven parks named solely as "national park" in Yunnan, which were constructed and managed by the Ministry of Forestry of Yunnan Province, China (Tang 2010). Apart from those called national parks, there are a number of

national parks in China which are also included in the national park system, including National Wetland Parks, National Forest Parks and National Geoparks (SFA 2017). For example, as the first national wetland park in China, the Xixi National Wetland Park of Zhejiang Province is one of the most famous parks for recreation, bird watching, academic studies and science popularisation (Chen & Xu 2006).

The national park system in China has attracted many criticisms. A primary one is that up till 2018, there is a lack of a national authority to oversee the park system, such as the National Park Service in the United States (National Park Service 2016) or the Department of Conservation in New Zealand (Department of Conservation 2018). This circumstance causes confusion and decreases efficiency when making policies, setting evaluation standards and conducting conservation projects or other relevant activities among the different types of national parks (Li et al. 2007). Another problem is there is no clear and official definition of what types of protected areas can be included in the Chinese national park system. In other words, there is a lack of the definition of the differences between national parks and other protected areas, resulting in many problems in tourism management and conservation. For example, Fritz (2009) suggested that nature reserves should be an important component of the Chinese national park system. The National Mine Parks and National Water Recreation Areas are also sometimes included in the national park system (Li et al. 2007; Tang 2010). Li et al. (2007) indicated that the National Scenic Areas should also be a part of the system[1]. The total number of national parks in China is, therefore, difficult to count. For the purpose of this project, the Chinese national park is defined as a system including National Parks (NP), National Forest Parks (NFP), National Geoparks (NG), and National Wetland Parks (NWP).

[1] The official translation of "国家级风景名胜区" is "National park" instead of the literal translation "National Scenic Area". This type of parks is, therefore, often included in the Chinese national park system by many authors. In this thesis, I prefer to call these "national scenic areas" rather than "national parks" because that is more appropriate to their designation. Obviously, this type of scenic area is outside of the scope of most national park systems. Thus, it is not included into the definition of the Chinese national park system here.

Encouragingly, a new Chinese national park system has been developing: a milestone of the development of China's national park is an official collaboration between the Paulson Institute of the United States and the National Development Reform Commission of the People's Republic of China (NDRC) in 2015. This long term collaborative plan is facilitated by China's government and focuses on the exploration of the most feasible management model for national parks in China, which should help to enhance management and development of the Chinese national park system (Paulson Institute 2015). In 2017, the State Forestry Administration of the People's Republic of China was confirmed as the highest national competent authority that is responsible for rebuilding and planning a clearer and more efficient Chinese national park system (State Council of the People's Republic of China 2017). In 2019, a milestone document *A Guide to the Construction of the National Park System* was approved by General Office of the State Council of the People's Republic of China, representing a new administration system and standards for Chinese national parks, which will be applied in a few years (General Office of the State Council PRC 2019).

2.3.3. The interpretation of natural attractions within a national park

Interpretation is an important component of most national parks and similar protected areas in the world (Ham & Weiler 2006). It is defined as the communication of the facts, values and relationships of natural and cultural heritage to visitors (Department of Conservation 2005). In a national park, the aims of such interpretation are to improve visitors' understanding of the concepts and stories of the local attractions and enrich their experience of visiting (Hvenegaard 2017; Mearns & Botha 2017). Moreover, successful interpretation can increase visitors' interests and awareness in terms of the topic interpreted (e.g. conservation) (Ismail 2008; Munro et al. 2008; Mearns & Botha 2017). Additionally, some forms of interpretation enable visitors to interact with experts or other visitors who have similar interests, which adds depth to their local experience (Department of Conservation 2005). In summary, Ham and Weiler (2006) stated that successful interpretation might have three main outcomes: (i) cognitive outcomes (e.g. understanding), (ii) affective outcomes

(e.g. appreciation, enjoyment, interest, awareness), and (iii) behavioural outcomes (e.g. changes in behaviour as a result of interpretation).

Based on the specific attractions of a national park, interpretation within the park may cover a range of themes, such as stories about nature, history and culture (Department of Conservation 2005). Amongst these themes, nature interpretation is the focus of this thesis, because experiencing nature is a key reason that tourists visit most national parks (Van der Merwe & Saayman 2008; Scholtz et al. 2013). Nature interpretation may include a variety of topics in the field of natural science, such as biodiversity, conservation, geology, ecology and environmental science (Department of Conservation 2005; Hvenegaard 2017; Mearns & Botha 2017). Such interpretation is, in fact, a form of science communication. This view is championed by Tilden (2009), who suggested interpretation within national parks constitutes a form of academic teaching or instruction activities. Given this, existing toolkits and theories in the field of science communication (e.g. scientific visualisation, story-telling, audience-centred communication, etc.) (Burns et al. 2003; Soykan 2009; Dahlstrom 2014) are likely to help to develop effective interpretive science stories about nature within a national park. From a science communication perspective, the cognitive, affective and behavioural outcomes of interpretation correspond to the general definition of an effective science communication process: improvements in awareness, enjoyment, interest, opinions and understanding of science (Burns et al. 2003). The evaluations above are integrated into the design of this project when measuring and discussing the effectiveness of nature interpretation within national parks.

Such interpretation or science communication has significant implications not only for tourism (e.g. enhancing visitor enjoyment and enriching the experience of visiting) (Ham & Weiler 2006) but also for conservation (Department of Conservation 2005). Firstly, it helps visitors connect better with the local natural attractions and enriches their experience, encouraging repeat visiting and longer stays (Munro et al. 2008). Secondly, it informs visitors what the iconic nature attraction is and why we have to protect it. Also, it enhances visitors' understanding and awareness of the relevant topic (e.g. conservation, climate

change, etc.), which can influence the public's understanding and support for conservation (Department of Conservation 2005). As found by an Australian survey on the conservation of the native tree-kangaroos and other animals, if residents have more knowledge about wildlife, they will tend to support relevant conservation activities (Tisdell & Wilson 2004). Communication of nature stories within national parks is, therefore, one way to deal with global conservational and environmental issues. The facts above suggest that all three aspects are important and are sometimes related to each other (Ham & Weiler 2006).

For a national park, nature interpretation can be conducted through a number of activities, products and locations (Department of Conservation 2005; Ham & Weiler 2007; Moscardo et al. 2007). Within the park, a guided tour is a popular personal interpretive activity, while the interpretive signage is one of the most common nonpersonal (i.e. self-guided) interpretive products (Department of Conservation 2005). In addition, to share nature stories to a broader audience and encourage visits, offsite interpretative activities are also adopted by many national parks. For example, online interpretive platforms are increasingly popular in recent years. Not only are websites and weblogs widely used, but also mobile applications (e.g. WeChat, the most popular social media applications in China) are applied to communicate science stories about natural attractions (Hvenegaard 2017; Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018). Some examples of interpretation are classified in Table 2-1 (Department of Conservation 2005; Hvenegaard 2017).

Table 2-1 A classification of commonly used interpretive activities and products.

	Onsite	**Offsite**
Personal (guided)	Guided tours, onsite presentations	Classroom, special offsite events
Nonpersonal (self-guided)	Signage, exhibits, brunches, arts, audio-visual displays	Websites, blogs, mobile applications, offsite exhibits

Compared to nonpersonal interpretation, personal interpretation is suggested to have a more significant influence on visitors' satisfaction and understanding (Hughes & Morrison-Saunders 2005; Munro et al. 2008). Also, tourists are more likely to be impressed by personal interpretations than the interpretive signage or exhibits (Ren & Folta 2016). For a national

park, this means that the effectiveness of nonpersonal interpretation still has room for improvement. Since a majority of visitors are self-guided within most national parks throughout the world, nonpersonal interpretive products are the only potential means for these visitors to connect with the unique natural attractions and increase their understanding of natural science (Department of Conservation 2005; Ismail 2008; Soykan 2009). There is a need, therefore, to develop better and more effective ways of communicating science stories about the natural attractions within national parks (Quigg 1978; Burns et al. 2003; Arabatzis & Grigoroudis 2010). The next section discusses what is needed to improve the effectiveness of science communication within national parks and introduces photography as a potential tool that can enhance communication.

2.4. Can photography enhance nature interpretation?

2.4.1. Effective nature interpretation

When aiming to make nonpersonal interpretive materials more attractive and effective, existing studies and guidelines for the design of such products mainly focus on the textual and visual elements, especially the textual content and the design (layout) of the product (Department of Conservation 2005; Ismail 2008; National Park Service 2018). Generally, Ham (1992) states that an interpretive product (e.g. a panel or a sign) should be attractive, brief and clear. Regarding the textual information, the title of the interpretive material should reflect the theme interpreted, and the textual story should be well-organised, short and interesting enough because visitors are not likely to read and recall long and complicated information (Department of Conservation 2005; Dandan 2012; National Park Service 2018). In terms of the design of interpretive signage, Department of Conservation (2005) suggests using some visual elements can create an attractive and pleasing design. As a widely-used visual element, images, especially photographs, are commonly mentioned when discussing the design of an interpretive product, because an appropriate photograph can provide an example of a certain nature attraction (e.g. a bird species) and environmental/biodiversity

changes within a national park (e.g. vegetation regeneration or habitat loss) (Dandan 2012; Department of Conservation 2018).

2.4.2. Visualisation in science communication

Even though images are frequently used in interpretive products, there have not been any studies that specifically examined the role of images for communicating natural attractions within a national park. This has left a gap in our knowledge about the efficacy of photographs for interpretation. For many guidelines of national park interpretation, images are merely used as supportive add-ons, with the main focus being on the textual stories and the overall design of the material (Department of Conservation 2005; Tilden 2009; National Park Service 2018). However, when discussing nature interpretation within the context of science communication, the potential of images to enhance nature interpretation should not be disregarded, because visualisation can be one of the most effective aspects of science communication (Houts et al. 2006; Frankel & DePace 2012).

For science communicators, visualisation through images is considered a powerful tool to increase individuals' understanding and recall of the scientific discourse (Trumbo 2000; Houts et al. 2006; Frankel & DePace 2012). Understanding and recall are emphasised here because they are vital aspects when evaluating the effectiveness of science communication (Burns et al. 2003). Curtis et al. (2012) noted that visual arts such as images could synthesise complex scientific facts and ideas in an engaging form, which makes the scientific discourse more attractive and easy to understand (Houts et al. 2006). Moreover, individuals who read information plus relevant images performed much better in knowledge recall compared with those with the same information but without any images (Patel et al. 1990; Delp & Jones 1996). For example, Patel et al. (1990) conducted a study in Africa with the context of the preparation and administration of treatment for dehydration. Results suggested that participants could recall more information after reading the material with pictures compared to the material without a picture.

Apart from understanding and knowledge retention, a positive emotional response is also an important outcome of effective science communication (Burns et al. 2003). Thus, another aspect of the importance of photographs for science communication is that appealing images can evoke positive emotional responses that enhance attention and engagement (Houts et al. 2006; Van Dijck 2008; Serafini 2011). Not only is photography a tool that can reproduce the status of objects and creatures, but also it is a form of contemporary art (Freedman 2000; Cotton 2009). There is a close relationship between such visual art and people's positive emotional responses (Silvia 2005; Curtis et al. 2012). Emotional responses to images include interest (e.g. attention) and engagement (Betts & McNaughton 2003; Silvia 2005; Houts et al. 2006). For example, in a health communication study, Delp and Jones (1996) gave half of their patients the treatment instructions with images but gave other patients the handouts with no pictures, then they found that the patients with an illustrated handout (text plus pictures) were more likely to read it. Also, Levie and Lentz (1982) and Levie (1987) reported that children preferred stories with images than those without images since the visual representation was more enjoyable for them.

In the context of science communication for nature, images, especially photographs, are also a suggested tool (Husain et al. 2017). Not only can images evoke emotions and improve understanding and knowledge retention, but photographs are also able to present the real status of creatures, objects or scenes in an objective and appealing way (Caivano 2008; Curtis et al. 2012; Husain et al. 2017). For instance, tiny insects and unfamiliar endangered birds are difficult to encounter and identify for the majority of people. Through photographs, the public is able to get a good view of them (Houts et al. 2006; Husain et al. 2017). Another reason for emphasising photographs here is that they are easy to produce and appreciate compared with other types of images (Henkes 1975; Jacobi & Schiele 1989; Van Dijck 2008; Schifanella et al. 2015). Nowadays, photographs are used commonly by both the science community (O'Connell et al. 2010; Carr 2012) and the general public (Van Dijck 2008; Statista 2018). Photographic images can, therefore, provide a link between scientific stories and the public (Betts & McNaughton 2003; Caivano 2008; Carr 2012).

The roles of photographic images in science communication reveal the potential for using photography in nature interpretation within national parks. The next section considers what should be taken into account when using photographs for interpreting science stories about nature within national parks.

2.4.3. The role of visual characteristics of a photograph

Even though photography can play a considerable role in communicating science, not that every photograph is appealing or can improve communication (Savakis et al. 2000; Weng et al. 2012; Redi & Povoa 2013). The visual characteristics of photographs, including their subjects and visual qualities, should be considered when communicating science with photographs because individuals' responses to different photographs are closely related to these visual characteristics (Trumbo 1999; Department of Conservation 2005).

The subject is an important visual characteristic of a photograph and can cover anything from objects, scenes to creatures (Savakis et al. 2000; Nishiyama et al. 2011; Husain et al. 2017). The characteristics of the subject of a photograph may significantly influence its effectiveness for communication. First, the subject of a photograph should be relevant to the topic interpreted (Department of Conservation 2005). In the context of science education with presentation slides, Slykhuis et al. (2005) suggested photographs that were highly relevant to the text discourse attracted students to devote more attention than decorative photographs that were unrelated to the text did, reflecting the importance of the subject of photographs in communication.

Savakis et al. (2000) stated that with a selection of photographs, those with an interesting subject is preferred by observers. Individuals' preferences for different subjects are also significantly affected by personal experience: Axelsson (2007) pointed out that familiarity with the subject of a photograph is one of the most important factors that affected the preferences of observers. In a study conducted in Kaikoura, New Zealand, tourists' local experiences (what they did or preferred to do in Kaikoura) were also identified as a clear

indicator of the preferences of tourists for photographs of local attractions (Fairweather & Swaffield 2001).

Moreover, individuals' preferences for photographs are affected by the subjects in two ways: whether they are interested in the subject itself and whether they are fascinated by one or more characteristics of the subject of a photograph (Savakis et al. 2000; Fairweather & Swaffield 2001; Marešová et al. 2009). Savakis et al. (2000) suggested the subject might be even more important than the visual quality of a photograph as the most important attribute of a poor photograph in their study was that "the subject is not interesting". Other characteristics of the subject that affected the perceived appeal of a photograph include the actions and expressions for human subjects (Savakis et al. 2000) and the taxa, morphological traits and colouration for wildlife subjects (Lišková & Frynta 2013; Husain et al. 2017). For example, Marešová et al. (2009) asked their respondents to rank thirty-four photographs of milk snakes according to perceived visual attractiveness and found those photographs of colourful aposematic subjects (i.e. snakes with a combination of bright colours, such as red-yellow-black-ringed ones) contributed significantly to their perceived beauty.

Visual quality, which is affected by a series of visual attributes such as composition, lighting and sharpness (Savakis et al. 2000; Datta et al. 2006), is another vital characteristic of a photograph that determines whether a photograph is aesthetically appealing or not (Datta et al. 2007; Bhattacharya et al. 2010; Li et al. 2010b). Generally, a high-quality photograph is easier to attract an observer's attention than those average or poor-quality ones do (Hodas & Lerman 2012; Redi & Povoa 2013). Sugano et al. (2014) displayed a series of pairs of photographs with different visual qualities on the monitor of a computer, then invited participants to look at these pairs with their eye movements being tracked. Results confirmed people tend to fixate on high-quality photographs longer (Shimojo et al. 2003; Sugano et al. 2014). In line with that, in the context of the most popular social media platform in China: WeChat, Zhou et al. (2016) claimed that the poor quality of images is one of the major obstacles affecting the performance of popular science WeChat articles. Within the context of environmental communication, Hansen and Machin (2013) pointed out that composition,

perspective, angle, gaze and narrative were important visual attributes that enhanced the effectiveness of photographs for communication.

A question arises: considering the potential of applying photographs to communicate science through interpretive products, what is the specific influence of the visual characteristics of a photograph on its effectiveness to communicate science? Exploring this question may help to enhance the effectiveness of nature interpretation within national parks by selecting and using appropriate photographs. However, there have been no empirical studies that consider the specific role of high-quality photographs in natural science communication, even though a number of scholars have already recognised the importance of images in this field (Carr 2012; Husain et al. 2017).

It should also be noted that evaluating the visual quality of a photograph is a difficult and complicated process, because even though there are a few widely-used criteria such as "the rule of thirds" in terms of composition (Mai et al. 2011), it is still challenging to find a consensus with regard to many aspects such as colour harmonies and lighting conditions (Marchesotti et al. 2011). As this thesis focuses on the role of photographs with different visual characteristics in interpretive materials and includes the evaluation of visual qualities, commonly used methods to assess the visual quality of a photograph is reviewed in the next section. Some of these methods are adopted in this thesis to assess and control the visual qualities of the photographs involved.

2.4.4. Assessing the visual quality of a photograph

Techniques for assessing and selecting photographs based upon their visual qualities have received much attention (Ke et al. 2006; Datta et al. 2007; Datta & Wang 2010; Marchesotti et al. 2011). In most cases, the visual quality of a photograph is estimated based upon its aesthetic value (Datta et al. 2007; Nishiyama et al. 2011). Even though assessing the aesthetics of photographs is considered a challenging task (Marchesotti et al. 2011), scholars

have developed different techniques for evaluating the aesthetics of a photograph (Datta & Wang 2010; Marchesotti et al. 2011; Nishiyama et al. 2011; Tinio et al. 2011).

Generally, the aims of assessing the visual quality of photographs are to detect high-quality photographs and eliminate low-quality ones from a selection of photographs (Datta et al. 2007). In order to assess the aesthetics of a photograph as accurately as possible, different measurements have been developed for photographs of different subjects, but none of them has unanimously agreed upon criteria (Datta et al. 2006). Up till now, aesthetic value assessment in photographs is still a challenging topic. This is because: (i) the ambiguous measurements of visual data extracted from a photograph make it difficult to define "good" and "bad" visual quality, and (ii) subjectivity influences our appreciation when judging the quality of a photograph (Marchesotti et al. 2011), due to both personal tastes (e.g. preferred colours or subjects) and personal experience (knowledge of the subject and photography) are significant influencers of individuals' perceived visual quality of photographs (Marchesotti et al. 2011; Lebreton et al. 2016). For example, Nishiyama et al. (2011) believed the perceived visual quality (preferences or attractiveness) depended not only on the aesthetics, but also on the subject of a photograph (see also Section 2.4.3).

Approaches to evaluating the aesthetics of photographs can be categorised into two types: human observer-based methods and computational assessments (i.e. based upon using computer programmes). Traditionally, human observers were involved in the assessment procedure as judges, and photographs were scored by these judges based on a series of aesthetic attributes such as sharpness, exposure, composition and colouration. Applications of this approach are dpchallenge.com as well as www.photo.net, where professional and semi-professional photographers are able to score the photographs uploaded by users. However, this type of assessment has been criticised by some scholars as they are expensive (to invite observers/photographer experts), difficult to repeat and take too much time. Also, judges may not rate all photographs seriously as they have varied understandings of the criteria or they are in a hurry to complete this task (Li et al. 2010a; Chen et al. 2011).

In order to make the aesthetic assessment more objective, accurate and efficient, researchers started to explore programme-based computational approaches to assess the aesthetics of photographs (Datta et al. 2006; Ke et al. 2006). With RGB data extraction technics and regression models being involved, this topic has been developing fast since the beginning of the 21st century, and the accuracy of evaluations has increased significantly (Datta et al. 2006; Bhattacharya et al. 2010; More & Agrawal 2017).

In a number of computational methods, ratings based on human observers are also integrated, acting as a ground-truth of the aesthetic data for testing the reliability and increasing the accuracy of the encoded aesthetic attributes (Datta & Wang 2010; Aydın et al. 2015). During the computational procedure, the programme needs to take a series of training tasks in order to estimate the aesthetics more accurately (Datta et al. 2007). As an example, a commonly used computational aesthetic assessment application to assess the visual quality of photographs is Acquine (acquine.alipr.com) (Datta & Wang 2010). It is a project run by Prof. James Z. Wang's image aesthetics research group of Pennsylvania State University (Datta et al. 2006; Datta & Wang 2010). The computational system that extracts the objective attributes of photographs was built according to the earlier work by this group (Datta et al. 2006). The accuracy of the prediction model was then improved by the following training procedure: since 2009, photographs of varied qualities (assessed by the computational system first) had been randomly chosen and displayed on the front page of the Acquine website, then they were rated by the users of the website. With an increasing number of ratings from the website users, the system has been able to rate the aesthetics of photographs more accurately (Datta & Wang 2010). Currently, users are able to upload photographs via the website. The system will then immediately give an aesthetic score (ranging from 0 up to 10.0) for the photograph. Considering the accuracy and convenience of Acquine, it was adopted to measure the visual qualities of photographs involved in this thesis (Chapters 3, 4 and 6). The next section describes two interpretive products involved in this thesis to explore how the visual characterises of a photograph affect its effectiveness of communication.

2.5. The interpretive products involved in this thesis

There are many existing interpretive products within national parks throughout the world, such as signage, booklets and online interactive applications (Department of Conservation 2005; Ismail 2008; Province of Nova Scotia 2008; National Park Service 2018). To explore how photographs may enhance science communication in national parks, I selected two representative and widely-used nonpersonal interpretive products as the specific contexts for this thesis. They are: (i) one of the most commonly used onsite interpretive products: interpretive signage (Patin 1999; Ballantyne et al. 2006), and (ii) the most popular social media platform in China: WeChat (i.e. interpretive WeChat Public Account articles) that makes it possible to conduct offsite interpretation in a more interactive way (Harwit 2017; Tencent 2017). Existing studies on the effectiveness of communicating through the two products above, as well as the research opportunities are reviewed below.

2.5.1. The potential of photographs to enhance the performance of interpretive signage

In order to provide particular information to the public, signage is common in both urban and wilderness area, including national parks (Department of Conservation 2005; Ismail 2008; Province of Nova Scotia 2008; Kelling & Kelling 2014). For a national park, the purposes of setting up signage usually include the following aspects: (i) interpreting stories about local natural attractions (to make the unfamiliar familiar, i.e. interpretive signage), (ii) indicating the name and suggested activities in a particular area (i.e. location information signage), (iii) showing directions and maps (direction signage) and (iv) pointing out prohibited activities or potential dangers (warning signage), as shown in Fig. 2.1 (Espiner 1999; Department of Conservation 2005; Ballantyne et al. 2006; Ismail 2008).

Fig. 2.1 Different types of signage in natural areas: (a) interpretive signage, (b) location information signage, (c) direction signage (map) and (d) warning signage. Photos were taken in New Zealand by the author.

Interpretive signage (Fig. 2.1a) is one of the most widely-used methods to communicate nature stories in most of the national parks in the world (Patin 1999). For example, according to a survey in Yushan National Park, Taiwan, interpretive signage is the most preferred interpretive method by tourists (Wu et al. 2004). Typically, an interpretive sign includes textual information as well as relevant images, plus a good design to organise all the elements appropriately (Department of Conservation 2005; Province of Nova Scotia 2008). Such interaction of text and images has been considered as an important means of improving environmental communication (Hansen & Machin 2013).

The effectiveness of interpretive signage has been the focus of previous research (Ballantyne et al. 2006; Ismail 2008; Province of Nova Scotia 2008). On the basis of a survey in a Malaysian national park, Ismail (2008) demonstrated that the interpretive signage could significantly increase visitors' conservation awareness, and encourage tourists towards more

environmentally friendly behaviours as guided by the signage. After being exposed to conservation information provided by the interpretive signage, tourists even passed on these new perceptions to other visitors who dropped litter within the national park (Ismail 2008). Some governmental organisations have also recognised the significant role of interpretive signage for science communication within national parks. For example, the Department of Conservation of New Zealand, which is responsible for managing all the national parks in New Zealand (Department of Conservation 2018), published the *Interpretation Handbook and Standard* in 2005 (Department of Conservation 2005). This milestone document provides practical insights on clarifying the specific purposes of setting up interpretive signage as well as suggestions and standards about the design of the signage. Generally, it emphasises interpretive signage should provide specific knowledge of local attractions and increase the depth to the experience of places in an enjoyable way (Department of Conservation 2005).

On the other hand, even though most scholars and science communicators recognise the value of the signage for public education, a study of people who participated in wildlife tourism in Queensland claimed that the majority of visitors could not remember the information presented in the signage (Ballantyne et al. 2011). Specifically, Ballantyne et al. (2011) found tourists were impressed by the experience of wildlife encounters, but this was not significantly related to the effectiveness of interpretive signage. This criticism suggests that interpretive signage may not work as well as it is intended to, meaning there is room to improve its effectiveness.

As described above, existing literature and guidelines about interpretive signage focus on textual information (what to interpret) and design (size, font, layout etc.) (Department of Conservation 2005; Moscardo et al. 2007; Province of Nova Scotia 2008; National Park Service 2018), as well as the signage's overall effectiveness in the context of different national parks (Ismail 2008; Ballantyne et al. 2011). However, these guidelines barely refer to the use and value of imagery. In contrast to the lack of studies on the specific role of images for interpretive signage, the use of images, especially photographs, has been proved

to be an important and effective approach to visualising science in the broader field of science communication, though the specific effectiveness of photographs may be affected by their visual characteristics (Section 2.4). Therefore, relevant studies are needed to confirm the specific role of photographs for science communication through interpretive products and the influence of visual characteristics of photographs on their efficacy for communication. The outcomes may help to choose more appropriate photographs to interpret science stories about national parks, which potentially improves the effectiveness of science communication.

2.5.2. Interpreting science stories through WeChat articles

Nowadays, interpreting science through such online platforms (especially social media platforms such as blogs, Facebook and WeChat) has been an important way to increase the public's understanding of science and their interests in scientific topics (Minol et al. 2007; Brossard & Scheufele 2013; Li 2017). For national parks, not only are traditional means (e.g. interpretive signage) used to communicate science stories, but a number of online interpretative methods have been developed based on the popularity of the internet, computer science and smartphones (Department of Conservation 2005; Land-Zandstra et al. 2016; Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018). For example, a few Chinese national parks, such as the Xishuangbanna Rainforest National Park, have been using the popular social media platform WeChat to communicate science stories about local natural attractions and successfully attract a number of followers as potential visitors to the park (Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018).

As a product of Tencent Holdings Limited, WeChat is the most popular social network application for mobile devices in China over the past decade (Harwit 2017; Tencent 2017). After being released in 2011, the number of active users of WeChat experienced a dramatic increase. There were 1.11 billion active WeChat users by the year 2019 (Statista 2019).

The core feature of WeChat is instant messaging. Individuals can easily chat with their friends and even with the strangers nearby who are also using WeChat and sharing their locations. Also, users are able to share their personal status with text and images (i.e. WeChat Moments), then their friends can give a thumb-up (i.e. "like") or add comments under this status. Notice that there is no thumb-down feature in WeChat, unlike Western web-based social media platforms such as YouTube and Facebook. The WeChat Public Account is another vital feature of WeChat (Tencent 2017), which is one of the targeted interpretive platforms in this thesis. An individual or an organisation can easily create and design their own public accounts for use on the online platform run by WeChat. Then, they are able to push articles to the followers of this public account. If the readers think such a WeChat article is interesting, useful or impressive, they may press the "thumb-up", and/or share the article on their WeChat Moments to express positive responses. Up till 2016, more than 12,000,000 WeChat Public Accounts have been created by a considerable number of individuals and organisations (Statista 2016). WeChat and its public account thus provide an opportunity to communicate scientific stories more effectively than traditional communication platforms do (Jin et al. 2017). Based on the popularity of WeChat, it seems that interpreting science stories about national parks through WeChat Public Account articles has its particular advantages (popular, fast, easy to update and so forth) (Lien & Cao 2014; Jin et al. 2017; Li 2017) compared to traditional interpretive products (e.g. signage). Also, as an offsite interpretive method, such an interpretive WeChat article may disseminate science stories about a national park to a great number of people (WeChat users) who have not visited the park, which significantly extends the reach for communication and may motivate them to visit the park.

2.5.2.1 An overview of WeChat Public Account and its articles

The general structure of a WeChat article generated by a public account is text (including the title) as well as visual elements, such as images, videos and graphic elements. The users of WeChat need two steps to start reading an article pushed by a certain public account: (i)

choose a certain public account from the contents of public accounts that followed by them, (ii) click one of the articles pushed by this public account (detailed illustrations see Fig. 2.2).

Fig. 2.2 The structure and feature of WeChat Public Account, illustrated by the screengrab from an Android smartphone. Names of relevant features were interpreted in English in the figure. The secondary page (step II) can be entered by clicking one of the public accounts in step I (the contents of the public accounts followed).

As shown in Fig. 2.2, after entering the main page of a certain WeChat Public Account, the users are able to see the contents of their followed public accounts. These public accounts have been ranked by the time when their latest articles were pushed. The latest updated public account will be ranked on the top of the contents. In the contents, the users can see the name of each public account on the first line (large font size, black), as well as the title of its latest updated articles on the second line (smaller font size, grey). The logo of each public account is also presented to help the users recognise different public accounts more efficiently (see step I in Fig. 2.2). Then, if users would like to read the articles of one of the public accounts from the contents, they will need to click that public account. By doing this, they can enter the main page of a certain public account (see step II in Fig. 2.2). Users are then able to read the articles by clicking the title of them on this page.

One can simply scroll down the page to read the full text of a WeChat article. The pageview is counted by the WeChat system (multiple clicking by the same user will not be counted). If the users think the article is really interesting, not only will they click the article to read it, but also they may leave a comment, or a thumb-up, or share this article in their WeChat Moments. The screenshot Fig. 2.3 illustrated the end section of a WeChat article, where pageviews, thumb-ups and comments from the users are presented.

Fig. 2.3 A screenshot of the end of a WeChat article.

2.5.2.2 How does a WeChat article spread?

WeChat users do not need to be following the WeChat Public Account to read a certain WeChat article posted by it. The most important benefit of following a WeChat Public Account is that the followers can receive more articles pushed by it after following. Therefore, attracting more users to be followers is a vital task for most WeChat Public Accounts (Li 2017; Tencent 2017).

The followers of a WeChat Public Account are able to choose if they want to read after receiving an article from this public account (see the contents page in Fig. 2.2). This is the

first challenge for a WeChat article to be dispersed. Next, if users are impressed by the article, they may share it through their WeChat Moment to make this article available to their WeChat friends. WeChat users are able to share their personal photographs with a few sentences as well as links of WeChat articles via WeChat Moments (Fig. 2.4). As a result of sharing, this user's WeChat friends can see and possibly read the article as well. A successful article may receive above 100,000 or more page views and thousands of shares (Han et al. 2016; Zhou et al. 2016). A summary of the dispersal model of WeChat articles is illustrated in Fig. 2.5.

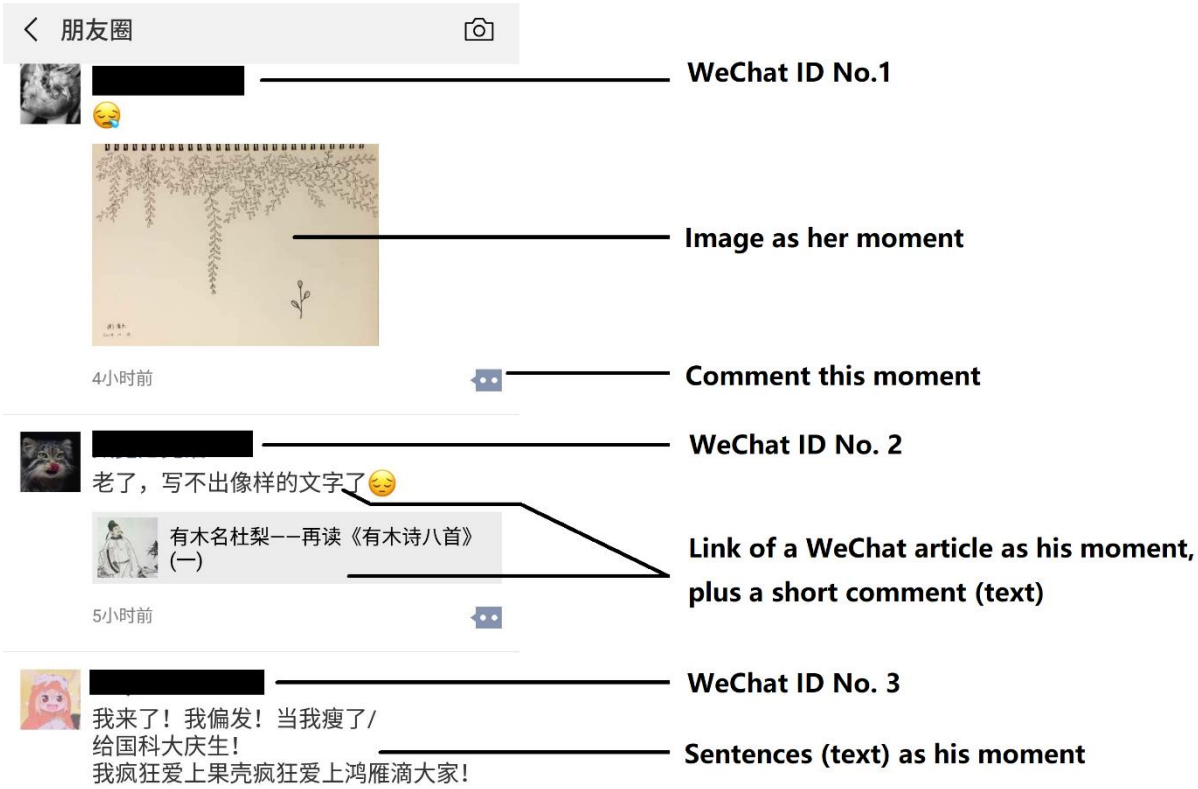


Fig. 2.4 A screengrab of the WeChat Moments with different forms of content (e.g. image, text, hyperlinks) being displayed. Exact WeChat IDs were hidden. This page can be scrolled down on a smartphone to see the WeChat Moments posted by more WeChat friends. Source: the author's own WeChat personal account.

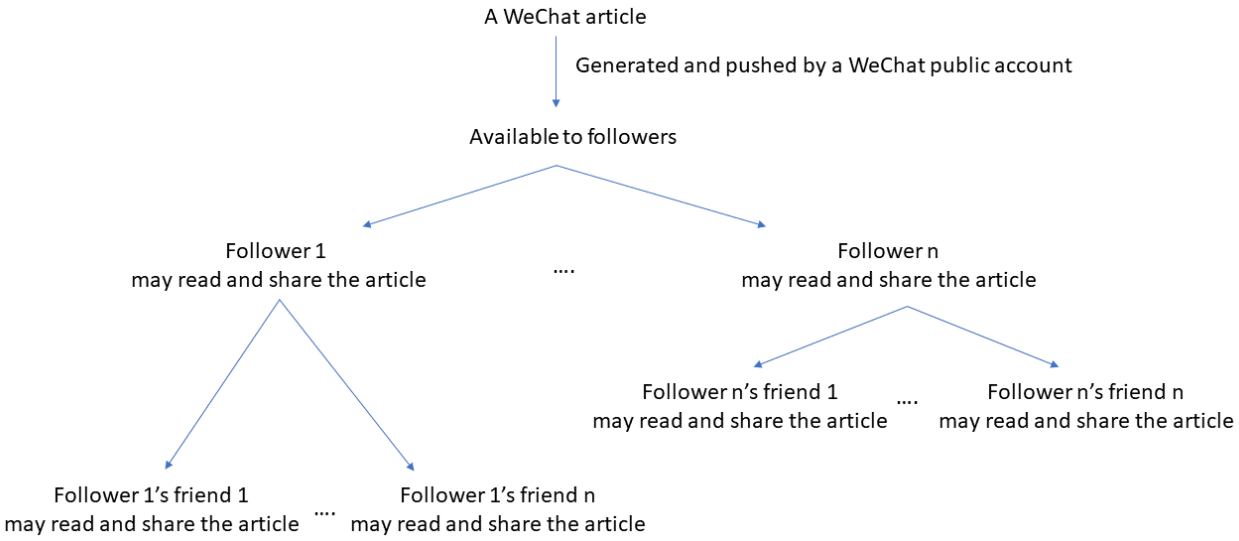


Fig. 2.5 The dispersal model of a WeChat article. Theoretically, a WeChat article can be dispersed infinitely in WeChat social net.

2.5.3. Improving the performance of WeChat articles: the role of imagery

Some 800 WeChat Public Accounts relevant to the communication of science have been run by different individuals and organisations in recent years, and this number is still increasing (Jin et al. 2017). However, the performance of these WeChat Public Accounts is not encouraging: compared to WeChat articles in other popular fields (e.g. business, politics, entertainment, health, sport and sex), WeChat articles about science, especially natural science, have relatively poor effectiveness (i.e. low page views, thumb-ups and shares) (Zhou et al. 2016; Jin et al. 2017; Li 2017). Specifically, Zhou et al. (2016) pointed out the current issues that WeChat articles in the area of science should deal with: (i) poor popularity and low frequency of pushing articles, (ii) poor content diversity: a number of authors just re-write or translate scientific information instead of producing original stories, and (iii) lack of visualisation: most popular science authors only use text in the articles, sometimes plus a few images with varied quality, resulting in low readability. Authors hardly ever use high-quality images, videos and interactive features. Science stories were thus interpreted in a monotonous and uninteresting way, which limited the effectiveness for communicating science (Wu et al. 2015; Zhou et al. 2016; Jin et al. 2017).

Even though there are many existing issues for popular science WeChat articles, WeChat Public Account is still a potentially useful interpretive platform for natural areas to communicate science. Given that the lack of visualisation is one of the major problems that limit the performance of popular science WeChat articles (Zhou et al. 2016), using appealing images may solve this problem. For example, on a range of online platforms such as websites and blogs, it has been suggested that appealing images can successfully get users' attention (Thorlacius 2002; Badger 2004; Thorlacius 2007) and increase user engagement (Sutcliffe 2009). According to the model of Thorlacius (2002) within the context of webpage design, an important function of images is the conative function, which is defined as "encouragement to interact". Specifically, an appealing image can prompt users' curiosity and other positive emotional responses, then motivate them to read more information on the website. Images are, therefore, a powerful tool for both navigation and interaction functions when designing webpages because both of the two functions are related closely to interaction (Thatcher et al. 2002; Thorlacius 2002; Werwath et al. 2010).

However, it does not suggest that all the images are effective for such online platforms: research has shown that the visual characteristics of an image should be considered (Weinman 1999; Thorlacius 2002). For example, Thorlacius (2002) suggested an attractive image for webpages should be pretty and colourful. Also, Djamasbi et al. (2010) conducted an eye-tracking study on the preference of young people (age 18-31) for images on webpages and concluded that these users preferred a large-sized main image as well as images of celebrities. In parallel, a study based on the use of photographs in popular blogs about sports showed that photographs of males are used more frequently than those of females (Clavio & Eagleman 2011), suggesting the importance of the subject of photographic images for enhancing the effectiveness for online communication. In addition, for the general purpose of science communication, high-quality images, especially photographs, have their potential advantages by: (i) presenting nature attractions in an objective and visually appealing way, which may evoke tourists' positive emotional responses, and (ii) increasing individuals' understanding and retention of the interpreted information (for details see Section 2.4).

Though employing appealing photographs may be an effective approach to improving the performance of interpretive WeChat articles about natural science, there is no empirical evidence to support this in the context of WeChat. So far, most researchers have focused more on the social and political influence of WeChat (Zhou et al. 2016; Harwit 2017). Research has confirmed that some textual elements, such as title and keywords, can affect the popularity of a WeChat article (Wu et al. 2015), but the question remains as to whether or how the visual characteristics of photographs may be related to the users' experience of reading WeChat articles about nature and whether they can influence the performance of such an article.

2.6. QR Code: linking WeChat and signage within national parks

An important reason for choosing both WeChat and interpretive signage as study materials is they can be linked by the use of QR codes (Liu et al. 2008). QR (Quick Response) code is a type of two-dimensional symbol that invented in Japan in the 1990s (Soon 2008). Compared to the traditional bar code, a QR code is able to contain data (e.g. a hyperlink) in both of its vertical and horizontal part, which makes the QR code much more informative than bar codes as URL links can be encoded into QR codes (Soon 2008; Kieseberg et al. 2010). Also, QR codes are easy to capture and recognise by smartphones (Liu et al. 2008). As a result, it has become one of the most popular approaches for advertising throughout the world (Okazaki et al. 2012), particularly in China where it is ubiquitous in signage in all facets of society (Liu et al. 2015; Qiu et al. 2018).

A hyperlink can be easily saved in a QR code (Liu et al. 2008), which can then be used to access a WeChat page, and this is an integrated part of WeChat (Wang & Gu 2016; Yang et al. 2016; Yu et al. 2017): every WeChat Public Account can automatically produce its own QR code that links to the front page of this public account (Yu et al. 2017). By this means, one can easily read WeChat articles and may follow the relevant account via a smartphone (Liu et al. 2008). WeChat, as an online interpretive medium, may potentially improve science communication within a national park when a QR code is used on the interpretive signage.

In such circumstances, the QR code contains a link to the national park's WeChat Public Account. Considering the story presented by a sign may be short and simple (Tilden 2009; Dandan 2012), this technique allows visitors to obtain more in-depth information (e.g. more relevant science stories). Accordingly, visitors are able to scan the QR code on the signage to acquire further information from relevant WeChat articles if they are interested in the content on the sign (Liu et al. 2015). Given this, tourists' willingness to scan the QR code on the signage is also considered as a part of the effectiveness of the signage for communication.

2.7. Research aims and questions

As reviewed above, interpreting stories about nature within national parks is an important approach to connecting the general public and nature, enriching visitors' experiences and improving their understanding of natural science. Given the potential value of photographs for science communication, the specific topic of this thesis was to investigate how photographic images can improve the effectiveness of nature interpretation. Specifically, the project was designed with the following three sections.

Firstly, before integrating the photographs in any interpretive products, I focused on the peoples' perceptions of the attractiveness of photographs. Participants' preferences and evaluations of a selection of nature photographs with different visual characteristics were analysed. Data were collected within two selected national parks in China, and results were presented and discussed in Chapter 3 and Chapter 4. In Chapter 3, I examined participants' preferences for nature photographs of a range of types of subjects and different overall visual qualities. While in Chapter 4, with a selection of photographs of birds, the potential implication of visual attributes of the subject for the perceived attractiveness of the photograph was examined.

Secondly, I looked at the effectiveness photographic images may have for improving communication within the context of a widely-used interpretive product: the interpretive signage. Specifically, within a selected Chinese national park, I examined the performance

of the existing interpretive signage within the park and the potential role of photographs (Chapter 5), then investigated the specific contribution of photographs to the effectiveness of the interpretive signage for science communication through a field experiment with manipulated signage (Chapter 6). This section was designed under a circumstance where photographs were practically applied to communicate the scientific stories about nature.

Lastly, apart from the traditional means to communicate information within national parks (e.g. signage), examining the effectiveness of images in new media (e.g. WeChat) to communicate scientific information about nature is also an important component of this thesis (Chapter 7). Within the context of interpretive WeChat Public Account articles about nature, the specific aims of Chapter 7 were: (i) to examine the visual and textual elements that may influence the performance such an article, and (ii) to explore how the visual quality of photographs affects individuals' reading experiences and post-reading responses.

Chapter 3. Preferences of Tourists for Photographs of Different Subjects and Visual Qualities

3.1. Introduction

As reviewed in Chapter 2, researchers have shown that developing tourism in national parks was a suggested approach to connecting humans and nature, enhancing understanding of nature and increasing awareness of existing environmental and conservation issues (Ismail 2008; Fritz 2009; Ballantyne et al. 2011). Within such parks, the interpretation of the science stories about local natural attractions plays an important role for enriching the visitor experience, providing enjoyment for visitors through the propagation of the scientific stories found within the park and increasing their understanding of nature (for details see Section 2.3.3) (Department of Conservation 2005; Ham & Weiler 2006).

When communicating scientific stories in national parks, researchers have to think carefully about the forms of expression and the elements involved, so that they can attract the general public more effectively and make them understand scientific stories better (Burns et al. 2003; Miller 2004). As discussed in Chapter 2, the use of images, especially photographs, is a potentially effective approach to visualising science stories (e.g. biodiversity) by improving their attractiveness and thereby gaining the public's attention, leading to increased enjoyment and understanding of scientific information (Debes 1968; Aigrain et al. 1996; Betts & McNaughton 2003; Brath et al. 2005).

It is important when discussing the use of photographs for science communication activities such as the interpretation within national parks, the visual characteristics (e.g. visual aesthetic appeal) of photographs should be considered (Bhattacharya et al. 2010; Redi & Povoa 2013). As suggested in Section 2.4.3, such visual attractiveness may be influenced by the visual characteristics of photographs (e.g. subjects and visual qualities) (Lišková & Frynta 2013; Schifanella et al. 2015). From the tourists' perspective, tourists themselves have

their own criteria for judging if a photograph of natural attractions within the park is appealing or not, which might be on the basis of their aesthetic preferences, their experience of visiting the park, or their interest in the subject of the photograph (Fairweather & Swaffield 2001; Dewar et al. 2007; Vessel et al. 2014). It is, therefore, important to explore tourists' preferences for photographs with different visual characteristics in order to use appropriate photographs in interpretive materials.

However, there is a lack of empirical studies that examine the attractiveness of photographs based on the influence of a combination of visual qualities and subjects, especially in the context of interpreting nature within national parks. To increase the effectiveness of interpretive materials within national parks by using more attractive photographs, I aimed to clarify tourists' preferences for different subjects and the visual qualities of photographs of the natural attractions within a national park. Given that the preferences of tourists might be affected by the visual characteristics of photographs and their interest in the photographs' subjects (Fairweather & Swaffield 2002; Marešová et al. 2009), the specific aims of this chapter are to explore: (i) the preferences of tourists for nature photographs with different visual qualities and subjects, and (ii) whether and how their preferences are affected by the tourists' characteristics (e.g. interests in the subject of the photograph). The outcomes of this section will help to: (i) select more appropriate photographs to interpret natural science stories within national parks, and (ii) better understand tourists' perceptions of the attractiveness of photographs.

3.2. Methodology

3.2.1. Study area description

The existing Chinese national park system is complex (for details see Section 2.3.2), and the ranges and qualities of different types of national parks are varied. This study was carried out in the Xixi National Wetland Park (XNWP) near Hangzhou City, Zhejiang Province (Fig. 3.1). It is approximately six kilometres from the city centre of Hangzhou. As the first national

wetland park in China, the XNWP has been open to the public since 2005. Covering an area of only 10.08 km^2, this tiny national park contains 511 species of vascular plant, 495 species of invertebrates, forty-five species of fish, twenty-five species of amphibians and reptiles, 126 species of birds and fourteen species of mammals, amongst which water birds and wetland plants are the main attractions (Shen et al. 2008; Miao 2009). Based on its rich biodiversity and importance to the local environment, the XNWP has been included in *The List of Ramsar Wetlands of International Importance* since July 2009 (Ramsar 2017). With respect to tourism, the XNWP is one of the most famous natural attractions not only for residents in Hangzhou but also for visitors from throughout China. This park attracts about 3,000 visitors during a normal working day. On public holidays, the number of visitors increases to over 10,000 (Rui & Liang 2007; Wang et al. 2009). Compared to the tourists in other regular parks, a number of visitors in the XNWP are particularly interested in wetland and water birds and are open to learning the functions of wetlands (Miao 2009; Pan et al. 2010). In summary, the high popularity and significant natural attractions of the XNWP (as an iconic wetland and its rich biodiversity) make it appropriate for this study.

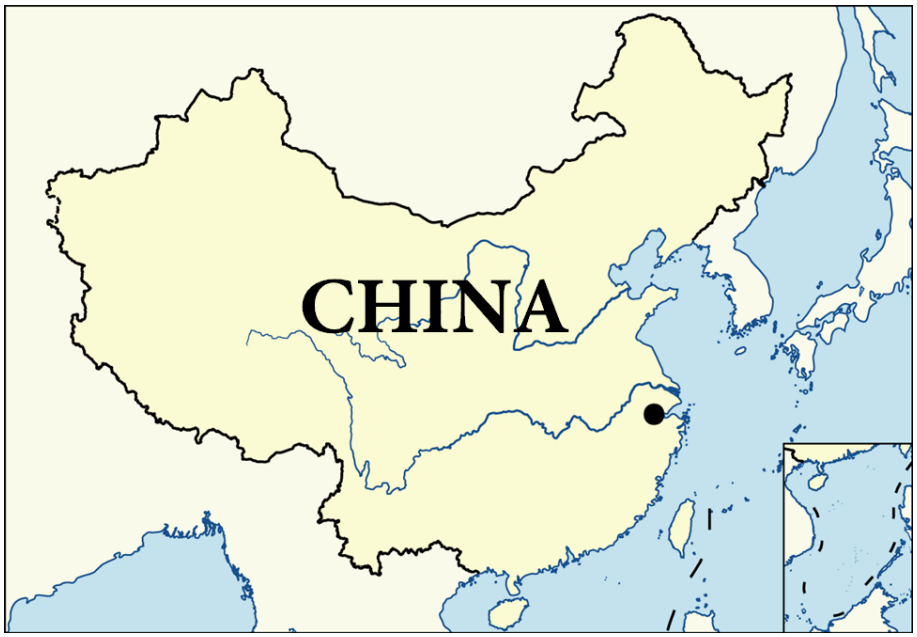


Fig. 3.1 Location of the Xixi National Wetland Park (the black dot). The boundaries and territories of China in the map, including the territorial sea illustrated by the dash lines in the inset, were drawn based on the National Bureau of Surveying and Mapping, the Peoples Republic of China (bzdt.ch.mnr.gov.cn).

3.2.2. The use of photograph-based Q method

This chapter focuses on the potentially shared characteristics of the preferences of tourists for photographs. The characteristics of these preferences can be extracted from participants' explanations for the photographs they liked and disliked when given a selection of photographs to assess. A photograph-based Q method was thus adopted for this chapter. This method is a widely applied approach to correlating respondents' subjective perceptions or preferences for a selection of photographs, then generating those shared patterns through factor analysis, so that participants' preferences can be described and interpreted through a few factors (McKeown & Thomas 2013; Schmolck 2014).

The study materials involved in Q methods are varied, including images and written or oral statements, which are determined by the specific purpose of the study (Brown 1980; Watts & Stenner 2005). However, the procedure for conducting Q method interviews is generally similar across different studies. To conduct a photograph-based Q method interview, respondents need to sort photographs based on their preferences and give an explanation for the result (e.g. why they like or dislike a certain photo). Explanations from respondents are important when interpreting the result because they can reflect respondents' underlying attitudes and can potentially reveal the link between the preferences of participants and the characteristics of photographs (Brown 1980; Dewar et al. 2007; McKeown & Thomas 2013). A study using Q method generally does not require a large sample size because the explanations from respondents can be used to complement the results when conducting a survey with a relatively small sample population (Fairweather et al. 1998; Dewar et al. 2007; Xiang 2010). Furthermore, the subsequent interpretation of the results of the factor analysis is an indispensable part of the method. Through interpreting the factors extracted, different patterns of preferences can be defined and described (Fairweather & Swaffield 2001, 2002; McKeown & Thomas 2013).

The use of a photograph-based Q method was appropriate here because it links different types of photographs to the visitors' preferences and interests. Specifically, a selection of

photographs (defined as the Q set), reflecting a variety of natural attractions within the XNWP, were provided to participants. Participants were able to sort these photographs based on their experiences, personal preferences and interests. The results of sorting are called the Q sorts (Brown 1980). The degree of similarities of the sorting between participants potentially helps to identify the subjects and visual qualities of photographs that are best for interpretation when using in the park.

3.2.3. The design of the experiment

A total of thirty photographs were selected as the Q set (Fig. 3.2). The visual qualities of the selected photographs in the Q set were measured automatically by an online approach: Acquine. This website-based evaluation system uses computational models to extract and assess the aesthetic values of the uploaded photographs (Datta & Wang 2010). An overview of Acquine is given in Section 2.4.4. The selected photographs were diverse (Fairweather & Swaffield 2001; Dewar et al. 2007), covering a wide range of visual aesthetic qualities (with scores by Acquine ranging from 2.2 to 10.0) and a wide range of natural science attractions within the XNWP (for details see Table 3-1). Some of these photographs were taken by me while others were drawn from the internet. All the photographs downloaded from the internet were approved to use in this project under a particular Creative Common License (Creative Commons 2017), for details see Appendix D.

As the main attractions in this national park are the wetland landscape, plants and wildlife (mainly birds), the photographs in the Q set included these subjects, plus a few local facilities in relation to the nature tour (e.g. a birdwatching hide, trails and interpretive signage introducing how to watch birds). All the species in the photographs are common within the XNWP. Birds were the subject of eighteen out of the total of thirteen photographs. These eighteen photographs covered six species of local birds, including both wetland birds and forest/shrub birds (Zheng 2011). The reason for using different species of birds is that their morphological traits, taxa and habitats may affect the observers' preferences for photographs of this type of bird (Marešová et al. 2009; Maple et al. 2010; Landová et al. 2012; Lišková

& Frynta 2013). Each species of bird (i.e. photographs of the same subject) had three photographs with different visual qualities, including at least one photograph with high visual quality (scored above 7.0) and at least one poor-quality photograph (scored below 7.0) (Datta & Wang 2010), see Table 3-1.

Table 3-1 The Q set (thirty photographs in total). The Common Kingfisher (*Alcedo atthis*), Mandarin Duck (*Aix galericulata*), Little Egret (*Egretta garzetta*), Vinous-throated Parrotbill (*Sinosuthora webbiana*), Light-vented Bulbul (*Pycnonotus sinensis*), Red-billed Blue Magpie (*Urocissa erythroryncha*), Black-spotted Frog (*Pelophylax nigromaculata*) and Globe Skimmer Dragonfly (*Pantala flavescens*) are locally common species.

Category	**The subject of the selected photograph**	**Photo ID**	**Scores by Acquine**
Local landscape	Pond with wetland vegetation	WV01	8.4
	Pond with wetland vegetation	WV04	5.8
	Pond with wetland vegetation	WV03	3.3
	Wetland, forests and bridge	RT02	5.1
	Wetland, reed and bridge	RT01	4.6
Local birds	Small wetland bird – Common Kingfisher	CK03	8.9
	Small wetland bird – Common Kingfisher	CK01	7.5
	Small wetland bird – Common Kingfisher	CK06	4.6
	Intermediate wetland bird –Mandarin Duck	MD05	8.7
	Intermediate wetland bird –Mandarin Duck	MD01	5.4
	Intermediate wetland bird –Mandarin Duck	MD03	7.7
	Large wetland bird – Little Egret	LE01	8.1
	Large wetland bird – Little Egret	LE06	8.5
	Large wetland bird – Little Egret	LE02	5.9
	Small passerine –Vinous-throated Parrotbill	VP03	8.5
	Small passerine –Vinous-throated Parrotbill	VP01	7.7
	Small passerine –Vinous-throated Parrotbill	VP02	6.2
	Intermediate passerine –Light-vented Bulbul	LB01	8.2
	Intermediate passerine –Light-vented Bulbul	LB04	10.0
	Intermediate passerine –Light-vented Bulbul	LB06	6.2
	Large passerine – Red-billed Blue Magpie	RM06	7.4
	Large passerine – Red-billed Blue Magpie	RM02	5.7
	Large passerine – Red-billed Blue Magpie	RM04	2.2
Wildlife other than birds	Black-spotted Frog	RG01	8.6
	Globe Skimmer Dragonfly	PZ01	10.0
Local plants	Forest (wide angle)	FR01	6.7
	One tree in the forest	FR02	5.8
	Shrub (close-up shot)	BS01	7.1
Local facilities	A bird-watching hide	HD01	6.1
	A bird information board (Interpretive sign)	SN01	5.9

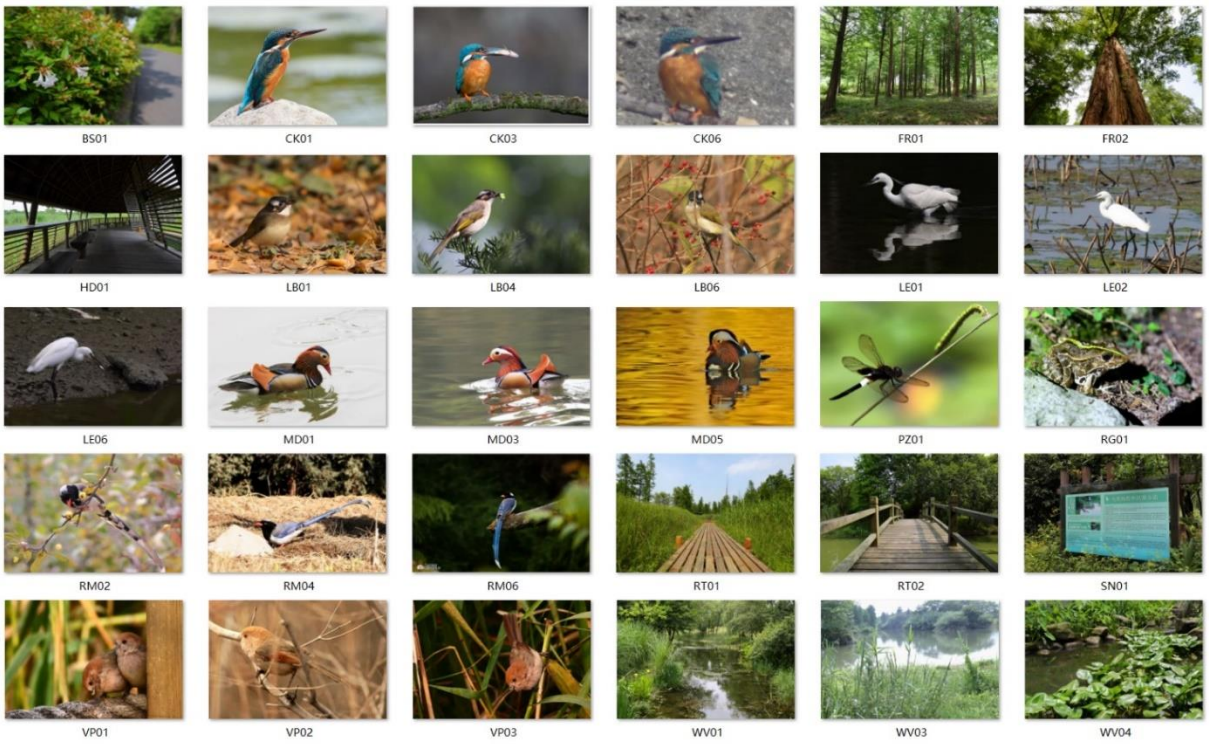


Fig. 3.2 A thumbnail view of the selected photographs.

3.2.4. Definition of participants' interests in birds

The photographs of birds comprised 60% of the Q set (eighteen out of thirty) with different species and a range of aesthetic values because birds are one of the major natural attractions within the XNWP (Rui & Liang 2007; Miao 2009). To avoid potential bias from personal interests when testing the attractiveness of the photographs, participants' interests in birds were examined and grouped. Participants were divided into three interest groups during the Q method interview by self-evaluation: (i) specialised bird enthusiasts – people with a specialised interest in birds (SB), (ii) individuals with a general interest in birds (GB) and (iii) those are not interested in birds (NB). Specifically, SB do serious bird watching, or their career (e.g. job or study) is directly related to birds. Thus, they have a good knowledge of birds. GB are interested in birds generally but do not have much experience and knowledge of birds. Those identified as NB professed not to care about birds much if at all. The above interests of the participants were used to describe the characteristics of participants loaded on each factor extracted through the Q method.

3.2.5. Interview procedures

All the participants were over eighteen years of age. Instead of random sampling, participants need to be diverse for Q methods, and the focused characteristics (i.e. interest in birds in this project) should be balanced (Fairweather et al. 1998). Specifically, the proportion of the three interest groups (SB, GB and NB) should be approximately equal. In order to meet these requirements, some of the participants were recruited within the XNWP (i.e. tourists in the park, mainly NB or GB) by personal invitation. Other participants (mainly SB) were recruited with the help from the local birdwatching organisation: Zhejiang Wild Bird Society. Through the approaches above, those individuals who had visited the XNWP recently (within six months) were encouraged to participate in the interview.

Each interview involved one interviewer (myself) and one participant and followed a set procedure. I introduced myself as the start of an interview, then briefly described this project as well as the procedure for the interview. An information sheet and a consent form were then provided. The participant would then ensure that he/she had read the information sheet and signed the consent form. Next, I noted a few characteristics of the participant (gender and interest in birds) using a smartphone. The next step was sorting the photographs, which was the vital part of the interview, following the protocol of a typical photograph-based Q method survey (Fairweather & Swaffield 2001; Milcu et al. 2014): The participant was given the thirty photographs (i.e. the Q set) and was asked to sort all the photographs into nine piles according to the question: *For these photographs that show natural attractions of the XNWP, what photographs do you like or dislike?* The nine piles thus represented the participants' different evaluations of these photographs. The set of piles and the quantities of photographs to be placed in each pile briefly resembled a normal distribution of liked photos, neutral and disliked photos (Dewar et al. 2007; McKeown & Thomas 2013; Milcu et al. 2014). For details see Fig. 3.3 as an example of a completed sorting (i.e. a Q sort). For the last step of the interview, the participant was politely asked to explain the reasons for choosing the three most and second-most liked and disliked photographs. It should be noted that during the interview, I did not provide the participants with any guidelines (criteria) to

help them explain why they liked or disliked a certain photograph, meaning that participants had to explain their preferences based on their own perceptions. As a participant only produced one Q sort, the total number of Q sorts was equal to the sample population of the survey.

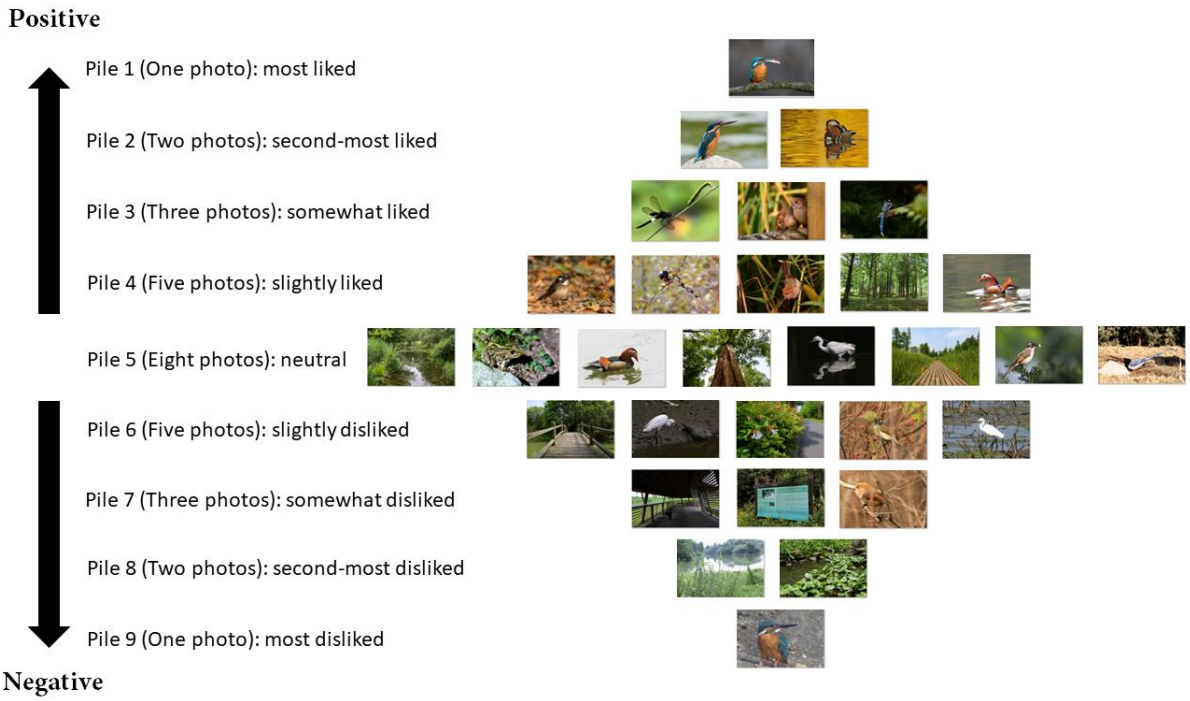


Fig. 3.3 An example of how the photographs were grouped into the nine piles by a certain participant (Q sorting). Piles represented different attitudes towards the photographs. The completed Q sort was, therefore, a diamond shape, reflecting a template of a normal distribution.

This survey was conducted from May 2017 to July 2017. Each interview session lasted about twenty minutes. Interviews were anonymous and were audio-recorded. Each participant was asked if he/she agreed to be audio recorded. If the participant was not happy with being taped, the interviewer would take notes with a notebook instead. This study has been approved by the University of Otago Human Ethics Committee (ID: 17/061). The detailed ethics approval, information sheet and consent form for participants were presented in Appendices A, B and C.

3.2.6. Q analysis and interpretation

All the Q sorts produced by the participants were processed as follows to undertake the subsequent factor analysis. As shown in Table 3-2, different scores were assigned to the nine piles within the Q sorts, from -4 (the most disliked pile of photographs) to +4 (the most liked piles of photographs), meaning that each photograph had a score given by each participant (Dewar et al. 2007). The factor analysis showed the potential correlations between different Q sorts. A few factors were then extracted and interpreted. The software used for this part of the process was PQMethod (Version 2.35), which was frequently used for Q-method data analysis (Schmolck 2014).

Table 3-2 The Q sort distribution is designed briefly based on a normal distribution.

Number of photos per pile	**1**	**2**	**3**	**5**	**8**	**5**	**3**	**2**	**1**
Score of each pile	-4	-3	-2	-1	0	+1	+2	+3	+4

Qualitative content analysis of participants' explanations for their choices was also applied to help interpret each factor, because these explanations not only reflected the participants' perceptions of their liked or disliked photographs but also presented the potential link between their preferences and the characteristics of photographs (e.g. subjects and aesthetic values) (Fairweather et al. 1998; Xiang 2010).

3.3. Results

3.3.1. Factors extracted and interpretations

A total of thirty-six participants, covering an approximately equal number of SB (twelve), GB (thirteen) and NB (eleven) participated in the interviews. All thirty-six completed Q sorts were photographed and then inputted into the database. Explanations for the Q sorts by participants were recorded in audio or in text, depending on the choice of the participant.

Four factors were extracted via the factor analysis after a varimax rotation (Schmolck 2014), explaining 71% of the total variance, see Table 3-3 for details. Results showed the participants' varied and distinctive preferences through four factors, which were likely to be influenced by personal interests, appreciation and experiences. Thirty-three out of thirty-six participants were significantly loaded on one of the four extracted factors and were used to describe each factor (significant loadings were detected and marked by the software), reflecting that these participants had shared characteristics of their preferences for photographs. The remaining three participants did not have a significant loading or had multiple loadings. The Q sorts produced by these three participants could not be used to define any single factors and were, therefore, excluded from the factor analysis (Watts & Stenner 2005; Schmolck 2014).

Table 3-3 Summary of the factor analysis (after a varimax rotation).

Factor	% of Variance	Number of participants loaded
1	27	13
2	16	7
3	18	9
4	10	4
Sum	71	33

Factor 1: Wildlife Photographs with Outstanding Aesthetic Value

This factor is defined by the Q sorts of thirteen participants (i.e. significant loadings), including seven GB, five NB and only one SB. It comprises 27% of the total variance. Table 3-4 lists the six photographs with the highest Q-sort scores.

Table 3-4 The six top-ranked photographs for Factor 1.

ID	Subject	Acquine score	Q score
MD05	Mandarin Duck	8.7	+4
CK03	Common Kingfisher	8.9	+3
CK01	Common Kingfisher	7.5	+3
RM06	Red-billed Blue Magpie	7.4	+2
LB04	Light-vented Bulbul	10.0	+2
PZ01	Globe Skimmer Dragonfly	10.0	+2

Not all the participants engage with birds (see the interest groups), but they do like appealing photographs: the visual aesthetic qualities of photographs became the most important factor amongst all four factors. All the six photographs are of high visual quality (Acquine score over 7.0, for details see Section 3.2.3), including the first, second, third and fourth highest scoring photographs in the Q set: PZ01 (10.0), LB04 (10.0), CK03 (8.9) and MD05 (8.7). The subjects of these six photographs are all wildlife: local wetland birds (the Mandarin Duck and the Common Kingfisher) and local forest/shrub birds (the Red-billed Blue Magpie and the Light-vented bulbul), as well as a wetland insect species (the Globe Skimmer Dragonfly). According to the statements from participants, high-ranking photographs for this factor were mainly described as clear, sharp, colourful and full of actions. According to their explanations, some respondents were also impressed by the narrative or atmosphere presented in the photographs.

On the other hand, the six photographs with the lowest scores for this factor are shown in Table 3-5. The bottom six photographs cover a variety of subjects, including local wildlife, vegetation and tourism facilities. However, it is important that all of them are poor-quality photographs. Here, negative statements mainly focused on blur and colourless subjects, not beautiful, not attractive, background too complicated, and so forth. The participants' explanations of their preferences for the above six top-ranked and bottom-ranked photographs were translated and presented in Appendix E.

Table 3-5 The six bottom-ranked photographs for Factor 1.

ID	Subject	Acquine score	Q score
VP02	Vinous-throated Parrotbill	6.2	-4
LB06	Light-vented Bulbul	6.2	-3
CK06	Common Kingfisher	4.6	-3
SN01	A bird information sign	5.9	-2
WV03	Wetland vegetation	3.3	-2
RM04	Red-billed Blue Magpie	2.2	-2

Factor 2: Local Birds Encounter

A total of seven participants were significantly loaded here, including five SB, two GB and no NB. Factor 2 accounts for 16% of the total variance. Compared to Factor 1, which reflected aesthetic-dependent preferences, Factor 2 showed a clear pattern of subject-related preferences. Participants associated with this factor focused specifically on birds. This factor was named as *Local Birds Encounter*. Table 3-6 presents the six photographs with the highest Q scores and the six with the lowest Q scores.

Table 3-6 The six top-ranked photographs (a) and the six bottom-ranked photographs (b) for Factor 2.

(a)

ID	Subject	Acquine score	Q score
RM06	Red-billed Blue Magpie	7.4	4
CK03	Common Kingfisher	8.9	3
RM02	Red-billed Blue Magpie	5.7	3
LB04	Light-vented Bulbul	10.0	2
LE01	Little egret	8.1	2
VP01	Vinous-throated parrotbill	7.7	2

(b)

ID	Subject	Acquine score	Q score
RT02	Forest and bridge	5.1	-2
HD01	A birdwatching hide	6.1	-2
WV03	Wetland vegetation	3.3	-2
WV04	Wetland vegetation	5.8	-3
CK06	Common Kingfisher	4.6	-3
SN01	A bird information sign	5.9	-4

All the participants loaded on this factor are interested in birds (i.e. SB and GB, with no NB). These participants, especially the bird enthusiasts, knew and had encountered many species of birds in the wild. These knowledgeable participants tended to evaluate the subject from a bird watcher's point of view: whether they were impressed by the behaviour and ecology of the bird in the photograph, and whether they thought the bird was rare or representative within the XNWP. For example, one of their reasons for choosing the Common Kingfisher (CK03) was that it appeared with a fish, which reflects both its habitat (wetland) and its typical behaviour. By contrast, GB, from their comment, did not care much about habitat

and ecology. Instead, they seemed to be attracted by some morphological traits of the birds. A participant who was loaded on this factor and had a general interest in birds, for example, preferred the photographs of a Red-billed Blue Magpie simply because it has an amazingly long tail. Also, for some locally common species, those GB would vote for them if they had seen them within the park.

Interestingly, for the six photographs that received more negative comments than others, only one photograph amongst them was of a bird subject: the CK06 Common Kingfisher, which had the lowest visual quality score in the Q set and was one of the four consensus photographs across the four factors.

Factor 3: Iconic Landscape and Environment within the XNWP

Factor 3 had nine participants (9 Q sorts) loaded, explaining 18% of the overall variance. Amongst the participants that defined Factor 3, four were SB, four were NB, and one was GB. Highly commended photographs for this factor were those of local iconic landscapes and vegetation (Table 3-7a). For example, three of the photographs showed different types of local landscapes: FR01 for the forest, WV01 for the wetland (river and vegetation nearby), and BS01 for shrub vegetation along the walking track. Especially, VP01, as the most preferred photograph by participants for this factor, presented a typical wetland path surrounded by reed (background). Accordingly, this factor was named as *Iconic Landscape and environment within the XNWP*. Six photographs with the highest and the lowest scores are listed respectively in Table 3-7a and Table 3-7b.

Table 3-7 The six top-ranked photographs (a) and the six bottom-ranked photographs (b) for Factor 3.

(a)

ID	Subject	Acquine score	Q score
VP01	Vinous-throated Parrotbill	7.7	4
CK03	Common Kingfisher	8.9	3
CK01	Common Kingfisher	7.5	3
FR01	Forest (wide angel)	6.7	2
WV01	Wetland vegetation	8.4	2
BS01	Shrub (close-up shot)	7.1	2

(b)

ID	Subject	Acquine score	Q score
RM04	Red-billed Blue Magpie	2.2	-2
LB06	Light-vented Bulbul	6.2	-2
WV04	Wetland vegetation	5.8	-2
LE02	Little Egret	5.9	-3
WV03	Wetland vegetation	3.3	-3
CK06	Common Kingfisher	4.6	-4

"As a bird watcher, I like the forest and reeds near the wetland. It means I am able to see lots of birds, especially during the migration season." (Participant 7, SB, for Photograph FR01)

"This photograph perfectly shows the wild birds in a natural environment. The moment captured in the photograph, including birds, reeds and walking trails, is representative for the XNWP." (Participant 29, SB, for Photograph VP01)

Even though these SB and NB evaluated photographs from different perspectives, they still reached consensus. They liked the natural and locally representative wetland environment. As a result, their choices of photographs mainly included those that contained or reflected this type of environment. On the other hand, examples of negative statements included "weird/ unnatural background" and "not a native or natural object (e.g. vegetation)".

Factor 4: Wetland Plants and Animals

Four participants loaded here significantly, including three GB and one NB, but no SB. This factor accounts for 10% of the total variance. Statements of participants who loaded here reflected these participants did not care much about whether the subject in a photograph was representative or unique within the XNWP. They were just generally interested in those natural elements and would like to connect with nature. Six photographs with the highest and lowest scores are listed in Table 3-8.

Table 3-8 The six top-ranked photographs (a) and the six bottom-ranked photographs (b) for Factor 4.

(a)

ID	Subject	Acquine score	Q score
VP01	Vinous-throated Parrotbill	7.7	4
CK01	Common Kingfisher	7.5	3
PZ01	Dragonfly	10.0	3
CK03	Common Kingfisher	8.9	2
WV01	Wetland vegetation	8.4	2
RM02	Red-billed Blue Magpie	5.7	2

(b)

ID	Subject	Acquine score	Q score
BS01	Shrub (close-up shot)	7.1	-2
LE06	Little egret	8.5	-2
WV03	Wetland vegetation	3.3	-2
HD01	A birdwatching hide	6.1	-3
SN01	A bird information sign	5.9	-3
CK06	Common Kingfisher	4.6	-4

Consensus statements

These four photographs had similar scores across the four factors (for details see Table 3-9). They are, therefore, defined as consensus photographs. These photographs do not help to describe factors, but some of them can still reflect participants' emotional responses. In particular, both the photograph with the highest visual quality (CK03) amongst all the thirty photographs and that with the lowest visual quality (CK06) are identified as consensus photographs here. The results show that even though for those participants whose preferences were mainly affected by the subject rather than the aesthetics (i.e. those loaded on Factor 2, Factor 3 and Factor 4), they still appreciated high-quality photographs and disliked poor photographs. For the other two consensus photographs LB01 and RG01, they generally received neutral scores, which represent that they did not arouse strong positive or negative sentiments during the interview.

Table 3-9 The photographs with consensus statements. The Q scores of each photograph for the four factors were given.

ID	Description	Scores by Acquine	Q scores			
			Factor 1	Factor 2	Factor 3	Factor 4
CK03	Common Kingfisher	8.9	3	3	3	2
CK06	Common Kingfisher	4.6	-3	-3	-4	-4
LB01	Light-vented Bulbul	8.2	0	0	0	0
RG01	Black-spotted Frog	8.6	-1	-1	-1	0

3.3.2. Implications of interests in birds

Four distinctive factors clearly showed participants' perceptions of the attractiveness of photographs. Visual quality (Factor 1) appeared to explain the largest proportion of the total variance. However, not every participant considered aesthetics as the most important indicator when assessing the attractiveness of a photograph. The characteristics of participants, especially their interests and knowledge in the photographs' subject, should be considered when analysing their preferences for different types of photographs (Lebreton et al. 2016). As the subjects of the majority of photographs used in this chapter were local birds, participants' interests in birds were taken into account to describe the characteristics of participants (i.e. SB, GB and NB). With regard to knowledge, SB, as bird enthusiasts or specialised bird watchers, are knowledgeable about birds, while GB and NB are generally not as knowledgable. As to interests, both SB and GB are interested in birds. By contrast, NB are not interested in birds. The results of the factor analysis reflect how different sets of people (based on the three interest levels above) responded to the photographs (Table 3-10).

Table 3-10 The characteristics/preferences of SB, GB and NB. F1 = Factor 1 Wildlife Photographs with Outstanding Aesthetic Value, F2 = Factor 2 Local Birds Encounter, F3 = Factor 3 Iconic Landscapes within the XNWP, F4 = Factor 4 Wetland Plants and Animals. Factors were sorted based on the numbers of participants loaded. For each interest group, the numbers in brackets present the number of participants significantly loaded on different factors.

Interest	Factor loading	Description
SB	F2 (5) > F3 (4) > F1 (1) > F4 (0)	Their preferences are closely related to birds, including species, behaviour and ecology presented in the photo. Their local birding experience also plays a role.
GB	F1 (7) > F4 (3) > F2 (2) > F3 (1)	They prefer aesthetically appealing photos, especially those that reflect the iconic local environment and wildlife (i.e. wetland and wetland wildlife, especially birds).
NB	F1 (5) > F3 (4) > F4 (1) > F2 (0)	They are attracted by aesthetics and enjoy a wide range of local landscapes and environment.

The preferences of participants with different interests in birds are distinctive (Table 3-10). Specifically, when evaluating the attractiveness of a given photograph, bird enthusiasts (SB) apparently prefer photographs of birds (i.e. the subject) rather than the aesthetics of a photograph. By contrast, the visual quality factor (Factor 1) is more important for GB and NB. Moreover, GB preferred photographs of the iconic environment and wildlife (related to the theme of the national park, i.e. wetland), while those NB could be attracted by a variety of types of subjects including landscape, vegetation and wildlife. The results above, especially those SB and GB, show that people's interests in the primary subject (taxa) of the photo were indeed taken into account when they evaluate whether a photograph is appealing.

3.4. Discussion

3.4.1. The role of visual aesthetics

As shown in the results, the visual quality of a photograph is indeed one of the most important factors that determine its perceived attractiveness. The factor that represents the influence of visual qualities (i.e. Factor 1) on participants' preferences explained the largest proportion (27%) of the total variance (for details see Table 3-3). While the visual qualities

were manipulated to include a range from low to high, this finding, nevertheless, suggests that tourists are able to discern the aesthetic value of a photograph. Specifically, when choosing preferred photographs amongst a selection with a similar subject but different visual qualities, participants showed great interest in the high-quality photographs and showed negative responses to those poor ones, particularly for the thirteen participants loaded on Factor 1.

Individuals' aesthetic appreciation of photographs is a complex and highly subjective topic: everyone has his/her own personal taste when judging the visual quality of a photograph. To assess the quality of photographs in an objective way, looking for potential consensus of aesthetic preferences has become a widely-discussed topic (Datta et al. 2007; Bhattacharya et al. 2010; Marchesotti et al. 2011). The present study shows that consensus of visual aesthetic appreciation, which was reflected in participants' preferences for photographs, indeed exists: photographs with high aesthetic scores could successfully gain more attention. By contrast, observers showed negative responses to those with poor aesthetic values (i.e. low Acquine scores). This finding is reflected not only by the first factor (F1: *Wildlife Photographs with Outstanding Aesthetic Value*), but also by those consensus photographs across the four factors: the photograph CK03 with a high aesthetic score (8.9) became the participants' favourite photograph, while the photograph CK06, which was defined as poor visual quality (Acquine score = 4.6), received extremely negative responses regardless of the factors, even though the subject of both CK03 and CK06 is the Common Kingfisher. Similarly, Husain et al. (2017) reviewed different types of nature and wildlife photography and concluded that photographs with high aesthetic appeal could get people's attention and enhance conservation. This study provided empirical evidence for the link between the visual aesthetic quality of photographs and participants' attention (reflected by preferences).

3.4.2. Important visual attributes

The results of this chapter show a clear link between the visual quality of photographs and the perceived attractiveness of them, suggesting the ability of participants to assess the visual

quality of the photographs. This was revealed by the importance of the visual aesthetic factor (Factor 1) and reflected in their explanations for their preferences. The participants' explanation was based on their own visual appraisal because I did not provide them with any suggested criteria. In such circumstances, participants still managed to pick out those photographs of high and poor visual quality (Factor 1) and referred to a few aesthetic attributes to support their sortings.

The descriptive content analysis on the participants' statements shows that the colourfulness of the subject of the photographs became the attribute most frequently referred to (mentioned nineteen times), followed by actions (mentioned eleven times). The concept "action" here included a variety of behaviours other than standing still. In addition, sharpness and exposure also appeared commonly in the respondents' statements (mentioned between five to ten times). For example, both "*The bird is colourful. (Participant 30 for Photo CK03)*" and "*I like this photograph because it shows the colourful feathers of the bird perfectly. (Participant 12 for Photo CK01)*" reflected that the participant was impressed by the colourful plumage of the subject in the photograph. On the other hand, negative comments generally focused on sharpness (mentioned eighteen times) and colourfulness (mentioned eight times), while exposure and composition were also mentioned but only five times for each. The findings above partly coincide with the findings of Lišková and Frynta (2013), who stated that when observers evaluate whether a picture of a bird is appealing, colourful plumage of the bird and the lightness of the picture are the most important factors.

Results also show that participants' knowledge of birds significantly influences their preferred photographs and focused visual attributes (e.g. colouration, sharpness, exposure and story-telling). A possible explanation is that aesthetic appreciation is closely related to the observers' relevant knowledge. Lebreton et al. (2016), for example, stated that when individuals evaluate the aesthetic appeal of a photograph based on a few visual attributes, their knowledge of photography plays an important role. While in this thesis, participants' knowledge of the subject (grouped by their interests: SB are generally more knowledgable

compared with GB and NB) significantly influenced their explanations for their preferred photographs.

Regarding participants' interests in birds, Factor 1 (the visual quality factor) covers fewer SB (one) than GB (seven) and NB (five). SB represents bird enthusiasts who are knowledgable about birds, while GB and NB do not have much knowledge of birds (for details see Section 3.2.4). This shows that visual quality is not that important for SB, whereas it is the most vital factor for GB and NB that determines whether they are attracted by a photograph of birds. For GB and NB loaded on this factor, their comments focused more on whether a photograph was sharp, with good lighting, colouration and composition, and whether the bird was colourful (beautiful), all of which did not require specific knowledge about birds (the subject) or experience in bird watching. Given this, it seems that when high-quality nature photographs are used in interpretive materials, these photographs are likely to attract more people who are not bird enthusiasts.

3.4.3. Interest-dependent preferences for different subjects

Factors 2, 3 and 4 reflected the implications of the photographs' different subjects rather than the visual qualities for participants' preferences. Factor 2, in particular, addressed a specific subject: birds. This factor focused on the specific subject rather than aesthetic aspects, and included those participants who preferred to use the following criteria when evaluating the visual appeal of a photograph of birds: whether the bird in the photograph is locally representative or morphologically impressive; if the behaviour is unique and interesting or if respondents had seen these creatures before.

Participants loaded on this factor showed a significantly interest-dependent pattern. All of the respondents loaded on Factor 2 were interested in birds, and most of them (five out of seven) were specialised bird enthusiasts (SB). This can be explained by Maple et al. (2010), who suggested that birdwatchers mainly focused on birds and were only interested in the interpretive materials about birds when visiting national parks. For SB, their criteria for

preferred photographs mainly included species, behaviour and ecology presented in the photographs, which can be supported by their knowledge and experience of birds and bird watching. For example, one participant (SB) stated, "*As a birdwatcher, I like the emotion expressed by the photo: The bird looks sleepy and relaxed. It is telling a simple but good story"* (Participant 9 for Photo MD05, the Mandarin Duck). It might reflect that SB tended to focus on the emotions expressed by the photograph more than objective attributes such as colourfulness. Also, those SB are knowledgeable enough to tell whether the moment in the photograph is difficult to capture. For example, Participant 9 gave the following comments on Photo CK05 (the Common Kingfisher with a fish): "*This is an amazing capture of a hunting kingfisher. Such a moment is very rare and very difficult to photograph*", suggesting how an observer's knowledge of birds helped him appreciate the photograph.

For those participants loaded on Factor 2 who have a general interest in birds (GB), morphological traits and familiarity of the birds in the photographs became important influencers. Here, the visual qualities of photographs are still not the main factor that impressed them. In these instances, people impressed by the morphological traits of birds were explained by Lišková and Frynta (2013), who found the morphological traits and colouration patterns in bird pictures determined their attractiveness to respondents. Furthermore, this European study presented that amongst a selection of morphological traits, the traits of eye, neck and tail (large eyes, short necks and long tails) significantly correlated to peoples' preferences, even though they did not test if the results were varied according to the respondents' interests in birds (Lišková & Frynta 2013). This study did not conduct a systematic comparison between different morphological traits, but, according to the participants' comments, it still revealed the positive influence of a long tail on participants' preferences. In addition, familiarity was another aspect participants took into account (for Factor 2). The findings in terms of familiarity match those of Axelsson (2007), who explored the implications of a few psychological factors on the aesthetic appreciation of photographs, and suggested that familiarity was one of the major factors determining the participants' perception of the visual appeal of a photograph.

3.5. Conclusion and implications

It can be concluded that the visitors within the XNWP had varied preferences for the photographs reflecting local nature stories, but they still shared some commonality in preferences when they assessed the perceived attractiveness of a photograph. Participants' appreciation was closely related to the visual qualities and subjects of the photographs. Those photographs with high visual qualities and attractive subjects were more successful in attracting attention.

For the majority of participants (i.e. GB and NB), the visual quality (determined by aesthetics here) of photographs became the most important indicator of its visual attractiveness, especially for those who were not bird enthusiasts (SB). When evaluating the visual appeal of a photograph, participants' focused visual attributes showed slightly different patterns in the positive and negative side. Generally, the photographs' colourfulness, sharpness, exposure and action (for the subject) were of more concern to participants than other visual attributes.

The subject of a photograph was another vital aspect that determined its attractiveness. Such an influence was, however, closely related to participants' interest in the subject (birds as the focused subject in this study). Bird enthusiasts assessed a photograph of bird(s) from an ornithological perspective. Appealing photographs for them might involve locally representative or rare species, or photos that captured unique or interesting behaviours, or included or reflected local iconic environments. However, sufficient knowledge of birds was required to conduct such evaluations, which was not difficult for those knowledgeable bird enthusiasts but not for GB and NB. For those who had a general interest in birds (GB) but were not as knowledgeable as bird enthusiasts, the morphological traits and colourfulness of the subject of a wildlife photograph were also important. These participants were also impressed by familiar subjects.

Using a photograph-based Q method, this is the first study of its type to examine the role of visual quality and the subject of the photographs used for nature interpretation. Results provide insightful context and explanations on the reasons why the observers preferred some photographs over others. To promote the communication and interpretation of local nature stories, the use of high-quality nature photographs to attract people's attention is a potentially effective approach. The present study provided evidence for the above hypothesis and confirmed the linkage between the visual characteristics of photographs and observers' emotional responses (preferences). That provides a global perspective in reference to the study's significance.

It should be noted that in terms of visual aesthetic attributes, the findings only suggest that colourfulness, sharpness, actions, species preference and exposure are important factors during the evaluation of the photographs' attractiveness. The descriptive content analysis does not provide enough evidence for the specific relative importance of each attribute for the perceived attractiveness of a photograph. Given this, the next chapter investigates the importance of the above visual attributes of wildlife photographs in a more systematic way.

Chapter 4. Visual Elements of Wildlife Photographs that Engage Tourists

4.1. Introduction

The interpretation of natural science stories is considered as an important component of natural areas such as national parks (Department of Conservation 2005; Ham & Weiler 2006). However, to communicate such stories effectively, appropriate visualisation is needed to draw individuals' attention and motivate them to obtain information about nature (Trumbo 1999; Burns et al. 2003; Estrada & Davis 2015). Within the context of interpreting natural attractions in national parks, this thesis aims to explore photography as a tool to communicate scientific stories about nature and clarify the potential influence of visual characteristics of photographs on their effectiveness for communication.

The second chapter of this thesis reviewed the potential role of photographic images for the communication of scientific stories about nature. As suggested by Husain et al. (2017) and Carr (2012), photography is an effective and powerful way to visualise scientific information: photographs of natural attractions can be attractive to the public, and such photographs are generally easy to understand and appreciate. Therefore, integration of images has the potential to improve the attractiveness of the interpretive materials within national parks, enrich the public's experiences of visitation and enhance their understanding of natural science (Debes 1968; Aigrain et al. 1996; Betts & McNaughton 2003; Brath et al. 2005).

However, as a creative and artistic expression (Husain et al. 2017), photographic images have varied visual characteristics, which makes them have varied attractiveness to observers (Savakis et al. 2000; Li et al. 2010a; Lišková & Frynta 2013). This fact increases the complicity and uncertainty for using photographs for interpreting natural attractions within national parks. The previous chapter confirmed that individuals' preference is significantly

influenced by the visual quality of the photograph and the characters of the subject (for details see Chapter 3).

According to the results of Chapter 3, the majority of participants stated that a few visual aesthetic attributes were important influencers of their preferences, even though it is difficult to compare the importance among different attributes based on the explanations by participants in Chapter 3. Similar cases were also found in other studies: based on ratings from observers, Savakis et al. (2000) compared observers' comments on a few visual attributes of photographs, then suggested a photograph that is colourful or with a good composition, or shows attractive facial expressions, poses and actions or representative events could receive more positive comments. However, the study above was carried out with a selection of photographs with the subjects of people and events (Savakis et al. 2000), while there are few existing studies on how those visual attributes influence the perceived attractiveness of photographs with nature as subjects. Two existing studies on images of birds emphasised observers showed their preferences for a few particular colours, suggesting that colouration is an important visual attribute to observers (Stokes 2007; Lišková & Frynta 2013). A study on people's altitudes on the photographs of milk snakes also suggested that observers preferred those photographs of colourful species of snakes (Marešová et al. 2009), but the focus of this study was on a single visual attribute (colouration). Further studies on comparisons of different visual attributes of nature photographs are still needed in order to choose the photographs with appropriate visual attributes for interpretation.

In this chapter, I aimed to test how different visual attributes of wildlife photographs may affect the perceived attractiveness of these photographs. Tourists' preferences for different photographs were used to reflect the perceived attractiveness. A few wildlife photographs with manipulated visual attributes were used as the study material. The outcomes of the study may provide evidence of the importance of aesthetic attributes for nature photographs. It also helps to use nature photographs more effectively in national parks so that they can better get the visitors' attention and interpret the nature sorties within national parks.

4.2. Methodology

4.2.1. Study area description

In this chapter, the study site was the Xishuangbanna Rainforest National Park (XRNP) of China, instead of the Xixi National Wetland Park in Chapter 3. The XRNP lies in Xishuangbanna Region of Yunnan Province (Fig. 4.1). This national park covers and protects the very last lowland tropical rainforest in China, which is the main natural attraction of this national park. The total area of the XRNP is 2854.21 km^2, including six main tourism regions and a nature reserve (Peng 2015). The survey that formed part of this project was undertaken in the Green Stone Region of the XRNP, as well as the nearby Rainforest Valley Region of the XRNP and the Xishuangbanna Tropical Botanical Garden (XTBG). The three sites above are next to each other. Access is by the same entry ticket as part of the XTBG complex. The main attractions of the XTBG (also the whole the XRNP area), as suggested by the name of each region, are rainforest as well as other tropical flora and fauna. The XTBG complex has been known as one of the most popular natural attractions in Yunnan Province. A total of 758,776 tourists visited in 2017 (Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018). The large number of visitors provided excellent opportunities for conducting field interviews and questionnaires.

Fig. 4.1 Location of the Xishuangbanna Rainforest National Park (the black dot). The boundaries and territories of China were presented based on the National Bureau of Surveying and Mapping, the Peoples Republic of China (bzdt.ch.mnr.gov.cn/).

4.2.2. An overview of choice-based conjoint analysis

According to the results in Chapter 3, the following visual attributes had noticeable influences on the appeal of selected photographs: colourfulness, sharpness, exposure and action of the subject (i.e. birds in the previous study). In this chapter, I examined the importance of the above visual attributes of a wildlife photograph for its perceived attractiveness by using a choice-based conjoint analysis.

The choice-based conjoint analysis (CBC) is classified as a type of discrete choice model (Johnson & Orme 2003; Orme 2006). With a variety of forms of regressions being involved, the CBC is applied frequently in marketing and landscape studies, especially when one is checking whether and how customers' preferences for products are influenced by certain attributes of these products (Claret et al. 2012; Jervis et al. 2014). In such studies, attributes or characters that potentially affect the preferences of customers are pre-determined, and each such attribute is measured or manipulated as categorical or continuous variables (i.e. predictors). Each combination of attributes is defined as a profile, which is used to describe

a certain product. Next, these profiles are grouped into different choice sets; each set thus includes a few alternatives (i.e. different products with pre-determined or manipulated profiles). Respondents are then asked to make a choice within each set (e.g. which product/profile you would like to purchase/choose), and they are also allowed to choose "none of them". Probabilities of respondents' selections are the dependent variable in the model (Chrzan & Orme 2000; Wiley et al. 2010).

The model of a CBC procedure generates two parameters: importance and utility (or part-worth utility). Importance represents how an attribute influences the respondents' choices. The value of importance ranges from 0% to 100%, with greater importance reflecting the more noticeable impact that a certain attribute has on the participants' choices, which reflects the relationships among different attributes (Chrzan & Orme 2000; Johnson & Orme 2003). The preferences of respondents for different manipulated levels of a certain attribute are reflected by a zero-centred parameter named as utility. In other words, the utility shows participants' preferences for different levels within an attribute. A higher utility means the level is preferred by the respondents while a lower value represents the respondents tend to avoid this level of an attribute (Orme 2006; Van Cauwenberg et al. 2016). In summary, the CBC model is able to measure the contributions (usefulness) of each attribute to the preferences of respondents.

The CBC analysis has never been applied in any research in the field of science communication. However, CBC has great potential to give insights into how to make communication more effective, such as here, where it is used to explore the preferences of tourists for the most effective photographs to use for communication. The photograph-based CBC analysis has been used to good effect to test the preferences of individuals for photographs of different landscapes. Van Cauwenberg et al. (2016), for example, tested the micro-scale environmental factors along the street preferred by different pedestrians through a CBC analysis with manipulated photographs of the street and found that sidewalk evenness was the most important element in the photograph for respondents. Such successful applications of the photograph-based CBC analysis on individuals' preferences showed the

potential of using this technique for examining participants' perceptions of photographs with different visual attributes.

4.2.3. Study design

The natural attractions of the XRNP are mainly rainforest and wildlife in such habitat (Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018). In this study, birds were used as an example of wildlife because they are one of the most noticeable and appealing taxa to the general public, and existing research about aesthetics and attractiveness of bird photographs was also available (Stokes 2007; Frynta et al. 2010; Lišková & Frynta 2013). The previous chapter also used photographs of birds with different visual qualities to test the preferences of participants. As illustrated in Fig. 4.2, this section uses the photographs of four species of birds: the Common Kingfisher (*Alcedo atthis*), the Little Egret (*Egretta garzetta*), the Velvet-fronted Nuthatch (*Sitta frontalis*) and the Lesser Shortwing (*Brachypteryx leucophris*) as the experiment material (i.e. the basic photographs) for the subsequence manipulations (Zhao 2001a). The Common Kingfisher is a colourful wetland bird which is abundant around lakes and streams in the XRNP. The Little Egret is also locally common near water, and it is entirely white with a small patch of yellow facial skin. The Velvet-fronted Nuthatch, as a colourful forest bird, is a typical forest species in the south of Yunnan Province of China. The Lesser Shortwing is a small brown passerine that is rarely seen in the forest of Yunnan Province (Zhao 2001b; Zheng 2011).

The focus of the study in this chapter is to test the influence of specific visual attributes on the preferences of observers. It is, therefore, important to keep the overall visual aesthetic qualities of the four selected basic photographs similar in order to reduce the implications of visual qualities, as such implications have been confirmed in Chapter 3. The visual qualities of these photographs were assessed through an online computational approach Acquine (Datta & Wang 2010), which is able to produce visual aesthetic scores (0 to 10.0) for each photograph. The Acquine scores of the four photographs ranged between 8.3 and 9.8 (the

Common Kingfisher 9.8, the Little Egret 9.7, the Velvet-fronted Nuthatch 8.6, the Lesser Shortwing 8.3), representing relatively high visual qualities (Datta & Wang 2010).

Fig. 4.2 The four basic photographs in the design: the Common Kingfisher *Alcedo atthis* (upper-left, public domain image from pixabay.com), the Lesser Shortwing *Brachypteryx leucophris* (upper-right, photographer: Xiangyu Guan, authorised for this project), the Velvet-fronted Nuthatch *Sitta frontalis* (lower-left, photographer: the author) and the Little Egret *Egretta garzetta* (lower-right, photographer: the author).

These four species of birds present a range of high to low colourfulness. The colourfulness (i.e. colour diversity) of the subject (i.e. the bird) was measured by an online colour extraction tool: TinEye (labs.tineye.com/color). This product allows users to upload images; it then extracted the colours appeared on each pixel of the image by its Multicolor Engine (TinEye 2018). Here, I accepted the suggestions from Lišková and Frynta (2013): if a certain colour presented on less than 3% of the pixels, this colour would not be considered as "present" (i.e. excluded from the counting). Thus, the Common Kingfisher and the Velvet-fronted Nuthatch were colourful birds (seven and six colours, respectively), while the Little Egret and the Lesser Shortwing were grouped as colourless birds (three and two colours,

respectively). Accordingly, the selected birds have a distinctive difference in colourfulness (two colourful species versus two colourless species).

Based on the results in Chapter 3, the sharpness, exposure and actions of the subject of the four basic photographs were selected as the pre-determined visual attributes in this experiment. The levels of each attribute, as characters of "products" (Claret et al. 2012), were manipulated by a range of two to four levels by Adobe Photoshop CS Version 6.0, including adjusting sharpness (with the motion blur module), exposure (with the exposure adjustment module) and reflect the actions of the subject (for details see Table 4-1). The examples of manipulations of sharpness were shown in Fig. 4.3. The manipulation of actions was conducted through the behaviours of the bird in the photographs (Axelsson 2007): taking food (action) versus stationary without food being taken (no action). The presence/absence of the food in the photograph was adjusted by Adobe Photoshop CS Version 6.0 based on the four basic photographs (see Fig. 4.2). As summarised by Table 4-1, the experiment included four manipulated visual attributes for a certain photograph: species (four levels), sharpness (three levels), exposure (three levels) and actions (two levels).

Table 4-1 Definitions of independent variables in the choice-based conjoint analysis. PS means the levels of a certain attribute was manipulated and adjusted by Adobe Photoshop CS 6.0.

Variables (Attributes)	**Manipulations/Descriptions**
Species (including differences in colourfulness, measured by TinEye)	Velvet-fronted Nuthatch: colourful (six colours), forest bird Common Kingfisher: colourful (seven colours), wetland bird Little Egret: colourless (three colours) wetland bird Lesser Shortwing: colourless (two colours), forest bird
Sharpness of the subject	High (clear and sharp without motion blur in PS) Slightly low (PS Motion blur: five pixels, 45°) Very low (PS Motion blur: ten pixels, 45°)
Exposure of the subject	Correct (adequate exposure) Underexposed (PS Exposure -1.0) Overexposed (PS Exposure +1.0)
Actions of the subject	Yes (a stationary bird with a piece of food being taken) No (a stationary bird, food was removed by PS)

(a)

(b)

Fig. 4.3 Examples of different levels of sharpness: high, slightly low and very low: (a) examples showing a 100% crop from the full-size image, (b) the same examples with the whole bird (resized). Adjusted by Adobe Photoshop CS Version 6.0 (Motion blur five pixels 45° for slightly low sharpness, while motion blur ten pixels, 45° for very low sharpness). The sharpness of the example photographs shown here was equal to those of the printed photographs. The background of the example photographs was cropped here.

The next step was to create profiles and cards for the CBC procedure (detail see the previous section). A profile represented a photograph with a certain manipulated level for each attribute (e.g. a photograph of Velvet-fronted Nuthatch, with high sharpness, correct exposure and no action). A card here contained four different profiles (i.e. four manipulated photographs) so that the respondents could choose their favourite photograph on each card. The statistical software XLSTAT 2018 was used here because the CBC module of this software was able to generate the optimized design of combinations automatically and

produce results of a CBC analysis easily (XLSTAT 2018). With the pre-designed visual attributes and their levels being input, XLSTAT 2018 could generate enough combinations (profiles and cards), but the total number of cards should be limited to reduce the complicity in the field exercise. As a result of the design, the software produced sixteen profiles (Table 4-2), which were automatically grouped into twenty cards (four different profiles/manipulated photographs on each card). In this design, each manipulated photograph with certain levels of the four attributes was shown repeatedly five times in total (on different cards, because profiles on the same card must be different, see Table 4-3). The size of photographs as jpeg files was fixed at 2100 × 1500 pixels, which was the minimum size for 5 × 7" photographs printed at 300 dpi, then they were printed (size = 5 × 7") for making the cards. The size of each card was 28 × 40 cm (with four 5 × 7" photographs).

During the exercise within the national park, participants (i.e. tourists) were asked to choose no more than one favourite photograph on each card. Given that participants' demographic information and interests in birds were likely to influence their preference (for details see Chapter 3), such information was also collected.

Table 4-2 Experiment design: the combinations of different levels of attributes and profiles, designed automatically by choice-based conjoint experimental design module in XLSTAT 2018.

Profile	**Bird/Sign**	**Sharpness**	**Exposure**	**Action**
Profile 1	Common Kingfisher	Very low	Underexposed	Yes
Profile 2	Little Egret	High	Overexposed	Yes
Profile 3	Lesser Shortwing	Slightly low	Correct	Yes
Profile 4	Lesser Shortwing	Very low	Overexposed	No
Profile 5	Velvet-fronted Nuthatch	Very low	Underexposed	Yes
Profile 6	Velvet-fronted Nuthatch	High	Underexposed	No
Profile 7	Little Egret	Slightly low	Correct	No
Profile 8	Common Kingfisher	High	Correct	No
Profile 9	Little Egret	Very low	Correct	No
Profile 10	Velvet-fronted Nuthatch	Slightly low	Overexposed	No
Profile 11	Velvet-fronted Nuthatch	High	Correct	Yes
Profile 12	Lesser Shortwing	High	Underexposed	No
Profile 13	Common Kingfisher	Slightly low	Underexposed	No
Profile 14	Common Kingfisher	Slightly low	Overexposed	Yes
Profile 15	Little Egret	Slightly low	Underexposed	Yes
Profile 16	Lesser Shortwing	Very low	Correct	Yes

Table 4-3 The twenty cards (choice sets) with four profiles (photographs with different attributes) for each are designed here by choice-based conjoint experimental design module in XLSTAT 2018, including the sixteen profiles above (five replications for each profile). Respondents will be asked to choose no more than one favourite profile on each card. The 5th alternative is "None of the above".

Cards (sets)	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5
Card 1	Profile 3	Profile 2	Profile 4	Profile 1	None of the above
Card 2	Profile 8	Profile 7	Profile 5	Profile 6	None of the above
Card 3	Profile 12	Profile 9	Profile 11	Profile 10	None of the above
Card 4	Profile 15	Profile 16	Profile 14	Profile 13	None of the above
Card 5	Profile 5	Profile 1	Profile 13	Profile 11	None of the above
Card 6	Profile 10	Profile 2	Profile 8	Profile 14	None of the above
Card 7	Profile 16	Profile 9	Profile 7	Profile 4	None of the above
Card 8	Profile 15	Profile 6	Profile 12	Profile 3	None of the above
Card 9	Profile 7	Profile 10	Profile 1	Profile 15	None of the above
Card 10	Profile 4	Profile 5	Profile 14	Profile 12	None of the above
Card 11	Profile 2	Profile 13	Profile 6	Profile 9	None of the above
Card 12	Profile 8	Profile 3	Profile 11	Profile 16	None of the above
Card 13	Profile 1	Profile 12	Profile 7	Profile 13	None of the above
Card 14	Profile 11	Profile 4	Profile 10	Profile 6	None of the above
Card 15	Profile 5	Profile 16	Profile 15	Profile 2	None of the above
Card 16	Profile 9	Profile 14	Profile 3	Profile 8	None of the above
Card 17	Profile 6	Profile 8	Profile 16	Profile 1	None of the above
Card 18	Profile 12	Profile 11	Profile 2	Profile 7	None of the above
Card 19	Profile 13	Profile 10	Profile 3	Profile 5	None of the above
Card 20	Profile 14	Profile 15	Profile 9	Profile 4	None of the above

The fieldwork was conducted from July 2018 to August 2018. Visitors within the XRNP were involved in the survey only if they had read the information sheet (Appendix F) and agreed to participate in the survey. After completing this, participants were kindly asked to complete a short questionnaire with a tablet (iPad mini 4) which contained two sections: socio-demographic information and interests in birds. I then asked a question: *These are photographs of different birds in this area, amongst the four photographs on each card, which photograph is the most attractive to you? Or none of them?* A total of twenty colour printed cards (Card 01 to Card 20, each card contained four photographs) were then given to participants. Participants needed to choose their preferred photograph from the four photographs on each card (plus the alternative "no favourite photo on this card"). This session would take approximately twenty to thirty minutes with one participant and one researcher (myself) being involved. Participants were gifted a postcard set with four

postcards after completing the survey. The minimum sample size should be 150 and the recommended sample size is 300 (Johnson & Orme 2003; Johnson & Orme 2010). The survey in this chapter has been approved by the University of Otago Human Ethics Committee (ID: 17/061), for details see Appendix A.

4.2.4. Definition of participants' interests in birds

In order to avoid the potential bias from personal interests when testing the attractiveness of photographs, participants' interests in birds were examined and grouped by self-assessment. Participants were divided into the following three groups according to their interests in birds when participating in this survey: (i) bird enthusiasts – participants with a specialised interest in birds (SB), (ii) participants with a general interest in birds (GB) and (iii) those are not interested in birds (NB). The grouping strategy above was similar to that in Chapter 3.

4.3. Results

During the recruitment period within the XRNP, a total of 322 visitors participated in the exercise. The usable sample population was 303 because the remaining nineteen participants did not complete the questionnaire or the subsequent exercise of choosing photographs. Socio-demographic information was collected before the exercise: ages, education levels, as well as their interests in birds, were used as the descriptive characteristics of participants. For a summary of socio-demographic information, see Fig. 4.4. The majority of the respondents were between eighteen and thirty-five years old (57.09% of the total sample population), which was higher than that of the actual age structure in China (National Bureau of Statistics of China 2017). There were also more female participants (54.13%) than males (45.87%), which cannot reflect the actual sex ration of the population in China, of which females accounted for 48.83% of the total population of China (National Bureau of Statistics of China 2017). In addition, participants of this survey were well-educated as 70.29% of them has a bachelor's degree or above. This is probably because a field research station of the Chinese Academy of Sciences is located in the XRNP, where there are a lot of students

and scholars doing their research. Also, the rainforest biodiversity and well-established interpretive signage have been attracting an increasing number of well-educated nature enthusiasts to observe the local flora and fauna (Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018).

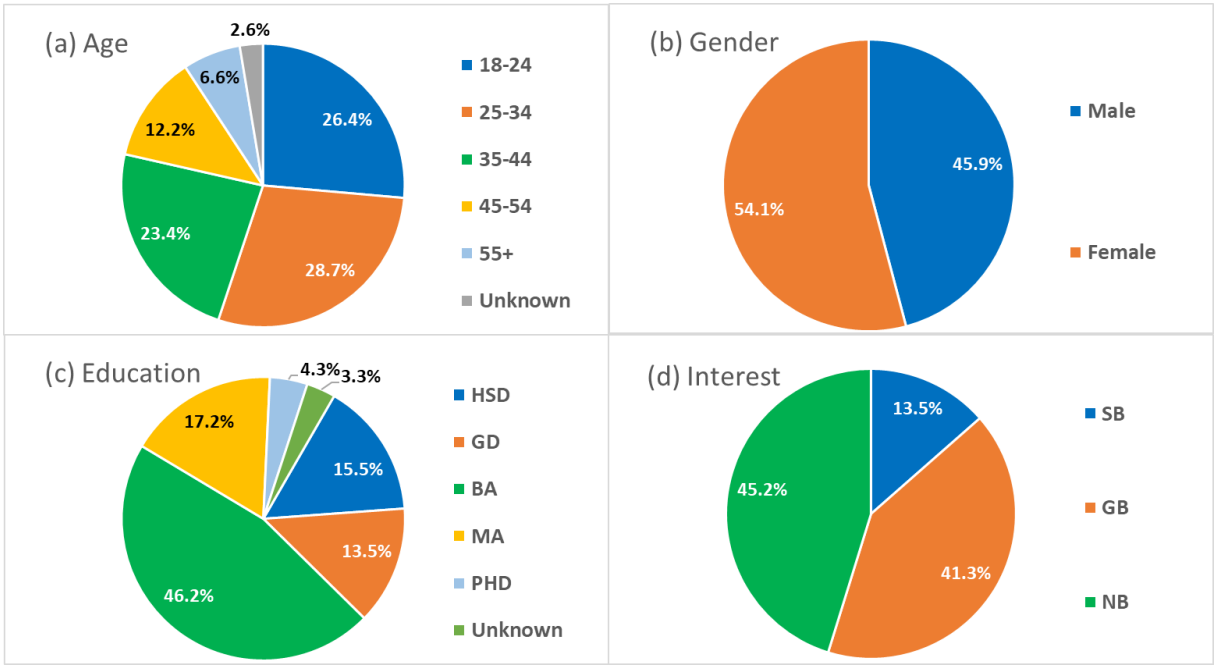


Fig. 4.4 Descriptive demographic information of respondents, n = 303. For the chart of education levels, HSD means a high school diploma or lower level, GD means a graduate diploma, BA means a bachelor's degree, MA means a master's degree or postgraduate diploma, and PHD means a Doctor of Philosophy. In the chart of interest groups, SB, GB and NB are the participants' interests in birds (for details see Section 4.2.4). Unknown represents the alternative "I do not want to say".

The results generated by XLSTAT 2018 present that the most relevant visual attribute for the preferences of tourists in the XRNP was the sharpness (importance = 54.91%), followed by the species of birds (23.44%), the action attribute (13.96%) and the exposure (7.68%), see Fig. 4.5. The differences between any two factors were distinctive. The utility of each manipulation of the four attributes above was also calculated (Fig. 4.5), which represented the preferences of tourists for the manipulations in detail. The negative and positive values of different manipulations for the same attribute reflected participants' trade-offs between one level and another (a larger value means a preferred level).

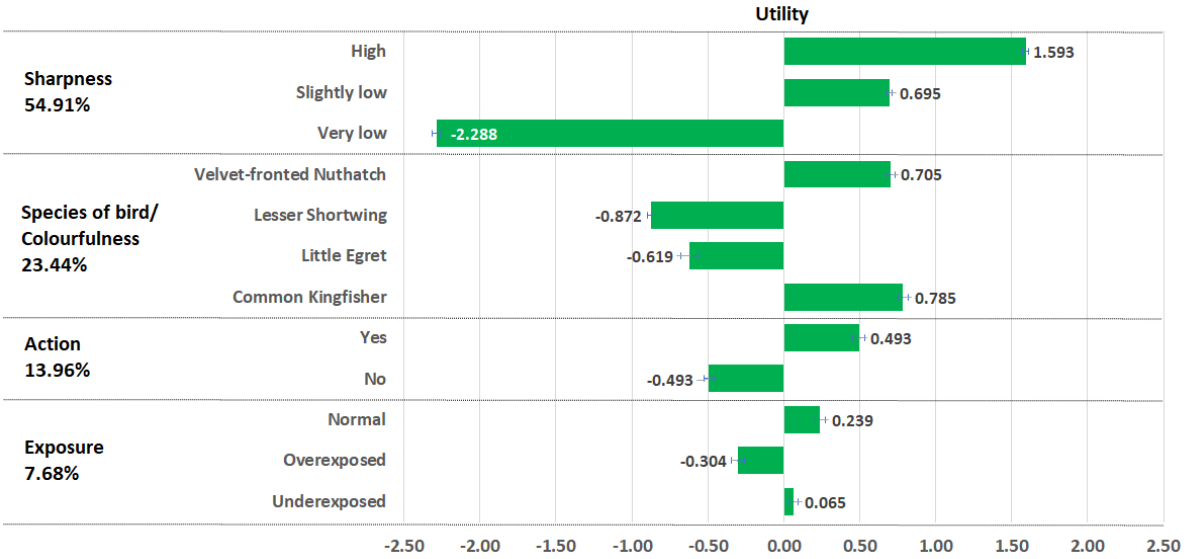


Fig. 4.5 A summary of the results of the CBC analysis. Proportions represent the importance of each factor (visual attribute). The utility of different levels of manipulations (with standard deviation) is also illustrated in the bar chart, n = 303.

As the most important visual attribute, sharpness had the highest (1.593 for the high sharpness level) and the lowest (-2.288 for the very low sharpness level) values amongst all the utilities. Surprisingly, tourists could tolerate a slightly blurry photograph (0.695 for the slightly low sharpness). The colourfulness of different species of birds was the second important attribute here. The colourful bird Common Kingfisher received the highest approval rate (reflected by the highest utility 0.785 in the species group), and the other colourful bird Velvet-fronted Nuthatch was also preferred by a number of tourists (utility = 0.705, slightly lower than that of the Common Kingfisher). On the other hand, the colourless forest bird Lesser Shortwing, as well as the white wetland bird Little Egret, got much lower utilities (-0.872 and -0.619, respectively) than those of the two colourful birds (i.e. Velvet-fronted Nuthatch and Common Kingfisher). In addition, actions also played a role here (0.493 for birds with actions and -0.493 for birds with no action), which was more important to respondents than exposure (utilities ranged between -0.304 and 0.239). Respondents thus indeed preferred bird photographs with actions, and with correct exposures.

Demographics of respondents did not have any noticeable effect on the results. The only finding was that the interest of participants in birds (mainly GB and NB group) was likely

to affect their perceived importance for different attributes (Table 4-4). Interestingly, the colourfulness of species was more important for NB (26.38%) than for other groups (23.27% for GB and 23.44% for the overall importance regardless of interest groups). Specifically, NB showed a greater interest in the two colourful birds (utility = 0.818 and 0.659 for Common Kingfisher and Velvet-fronted Nuthatch respectively), while GB also preferred the photographs of these species but had lower utilities (utility = 0.666 and 0.563 for Common Kingfisher and Velvet-fronted Nuthatch respectively). However, the sample size of the SB group was not enough for the underlying analysis (forty-one, much less than the minimum sample size available for the CBC analysis, which was 85 for this study). Therefore, only the utilities of different attributes for GB and NB were given by the software.

Table 4-4 The utility of each visual attribute. A higher value (above zero) means the relevant attribute was preferred by the users, and vice versa. SB, GB and NB represent different interest groups (Section 4.2.4). Sample sizes: overall = 303, SB = 41, GB = 125, NB = 137. An asterisk (*) means the value was significantly different from the overall utility (based on a t-test).

Attribute	**Importance (%)**				**Manipulation**	**Utility**			
	Overall	**SB**	**GB**	**NB**		**Overall**	**SB**	**GB**	**NB**
Sharpness	54.91	N/A	55.06	56.80	High	1.593	N/A	1.604	1.634*
					Slightly low	0.695	N/A	0.580*	0.808*
					Very low	-2.288	N/A	-2.185*	-2.442*
Species	23.44	N/A	23.27	26.38	Common Kingfisher	0.785	N/A	0.666*	0.818*
					Lesser Shortwing	-0.872	N/A	-0.935*	-1.075*
					Little Egret	-0.619	N/A	-0.293*	-0.402*
					Velvet-fronted Nuthatch	0.705	N/A	0.563*	0.659*
Action	13.96	N/A	10.49	13.02	YES (foraging)	0.493	N/A	0.361*	0.467*
					NO (stationary)	-0.493	N/A	-0.361*	-0.467*
Exposure	7.68	N/A	11.18	3.79	Normal exposed	0.239	N/A	0.418*	0.154*
					Overexposed	-0.304	N/A	-0.351*	-0.118*
					Underexposed	0.065	N/A	-0.067*	-0.037*

4.4. Discussion

4.4.1. Ranking the importance of visual attributes

This is the first attempt that examines and ranks the influences of visual attributes on the perceived appeal of wildlife photographs through CBC analysis. The results clearly gave the preferences of participants for the manipulated visual attributes. In particular, sharpness was the greatest rating of importance that affected the perceived visual appeal of a photograph. A sharp photograph had the highest utility within the sharpness group and even amongst all the four groups. Colourfulness was also an important influencer of participants' appreciations: photographs with colourful subjects were preferred by participants.

Sharpness has been known as an important visual attribute in the area of photography; it is, however, difficult to measure (Chen et al. 2011). In this study, I used the motion blur feature of Adobe Photoshop CS Version 6.0 to produce the different levels of blurry photographs based on the original ones with high sharpness. Results suggest participants felt strong antipathy against the "very low" sharpness (utility = -2.288), reflecting this extent of sharpness was apparently unacceptable for observers. Interestingly, respondents showed tolerance for the photographs with the "slightly low" sharpness (utility = 0.695). In addition, those sharp photographs (i.e. the basic photographs without being blurred by Photoshop) received the highest utility (1.593). However, it is lower than the absolute value of the utility for photographs with very low sharpness. This finding reflects participants were more sensitive to the photographs with very low sharpness. It confirms one of the findings in the previous chapter: the majority of participants pointed out and criticised blurry photographs, but they tended not to mention this attribute with a sharp photograph. This is probably because a sharp photograph can include many details of the subject, which may attract observers' attention more effectively (McGuire 1999; Tinio et al. 2011). In summary, when using the wildlife photographs to engage the public, the sharpness should be at least at the same level of slight low sharpness group in this study.

Colourfulness of the birds was also a key factor that influences the visual appeal of a wildlife photograph. Both the two colourful birds (the Common Kingfisher and the Velvet-fronted Nuthatch) received positive utilities (0.785 and 0.705 respectively), which were much higher than the utilities of the Little Egret and the Lesser Shortwing (-0.619 and -0.872 respectively). Two reasons could be found to explain the results: first, my previous survey in Chapter 3 suggested that photographs of colourful birds seemed to be preferred by respondents, especially those GB and NB, and this was supported not only by their choices but also through their explanations. In other words, birds with rich colour diversity could receive more attention. Here, both the Velvet-fronted Nuthatch and the Common Kingfisher had at least six colours, while the Little Egret and the Lesser Shortwing were colourless birds (three colours or fewer). The results thus complement the finding from the previous chapter. Secondly, Stokes (2007), based on his study with photographs of penguins, suggested colourfulness was indeed related to the preferences of individuals for wildlife: Penguins with more warm colours could receive more attention from respondents. In parallel, a case study on parrots showed that the colours blue, yellow and orange were more attractive to the public than other colours were (Frynta et al. 2010). In my study, the major colour of the Velvet-fronted Nuthatch is blue (upperparts) (Harrap 2008), while the Common Kingfisher mainly consists of the colour blue (upperparts) and orange (belly) (Woodall 2008). Given this, apart from the positive influence of colour diversity, Frynta et al. (2010)'s findings might also be able to explain the results above.

Regarding the implications of participants' interests in birds on their preferred photographs, a sharp and colourful subject (e.g. bird) could impress both GB and NB. Specifically, the colourfulness of the subject was more important for GB than for NB. In the previous study (Chapter 3), both NB and GN showed their interest in colourful birds, but the analysis was not able to distinguish which interest group concerned this attribute more. The present study thus developed a better understanding of the differences in preferences between GB and NB.

In the previous chapter, the relationship between the habitat of birds (the subject of the photograph) and the local environment of the national park was referred by a few

respondents. Especially, some SB were more likely to be impressed by species that could reflect local iconic habitats, such as a Common Kingfisher (wetland bird) in a national wetland park (detail see Chapter 3). As the largest rainforest national park in China, the main attraction of the XRNP (the study site) is apparently forest (especially rainforest). However, the two species of birds whose habitat were forest (Velvet-fronted Nuthatch and Lesser Shortwing) did not both draw more attention. Ironically, the two forest species above received the highest and lowest utilities respectively within the group of species of birds, while the two species of wetland birds (Common Kingfisher and Little Egret) also had the diametrically opposed utilities. The utility of the typical forest bird Lesser Shortwing was even significantly lower than that of Little Egret ($t = 84.33$, $p < 0.001$, $n = 303$). An explanation is that 86.47% of the respondents were GB or NB (with a general or no interests in birds). Thus, most of them did not know the habitat of the birds in the photograph as they might not be familiar with these species. The finding above is, in fact, in line with the results in Chapter 3 as GB and NB in the previous study also did not care whether the bird, as the subject of the photograph, was locally representative or not.

The manipulations of actions were differed by the appearance of food that the birds were taking (taking food versus not taking food). The importance of this attribute (13.96%) is not as significant as the two factors above were. Nevertheless, the preferences for actions were distinctive: participants preferred the bird with a certain action (utility = 0.493) and *vice versa*. This finding complements that of Axelsson (2007), who explored the observers' perceptions and evaluations of the visual appeal of a selection of photographs. Using 564 photographs, this Swedish study asked participants (undergraduate students at Stockholm University) to group these photographs based on the perceived visual appeal of them, then explain their classifications. Results showed that *Full of action* was an important attribute that could be found in most appealing photographs. The attribute *Full of action* represented behaviours of the animal (the subject) in wildlife photographs (Axelsson 2007), which was related to the manipulation of the levels of actions (if the birds were taking fish or insects) in my study.

4.4.2. Methodological Implications and potential extensions

The focus of the CBC analysis is to let respondents make multiple choices. Thus, it can be conducted both online and through field exercise (Orme 2006). For example, Van Cauwenberg et al. (2016) collected their data both through online questionnaires and face-to-face interviews in their street landscape study by the CBC analysis with manipulated photographs. In this chapter, I only applied the field survey (face-to-face interviews) within the XRNP as the exercise was closely related to the local environment and biodiversity. However, the weakness of such a field survey is the limited time and smaller sample size than an online survey could have. The sample size of this study is 303, which is acceptable for the subsequent CBC analysis (Johnson & Orme 2003; Johnson & Orme 2010; XLSTAT 2018). However, there were only forty-one bird enthusiasts (SB) amongst the 303 participants, meaning that the XLSTAT could not generate the importance and utility for SB. Therefore, future studies should be conducted in a longer time period, so that a larger sample population can be recruited.

The significance of sharpness and exposure were also addressed and confirmed by many researchers (Chen et al. 2011; Tinio et al. 2011). The preferences of individuals for the colourfulness of the subject, however, was seldom explored, with only a few cases being tested, especially in the area of wildlife or nature photography (Stokes 2007; Lišková & Frynta 2013). This study, therefore, developed the understanding of the topic above, and presented the importance of colour diversity of the subject of a wildlife photograph for its visual appeal.

4.5. Conclusion and implications

To conclude, the results based on manipulated photographs clearly reflect the importance of the four visual attributes (sharpness, colourfulness, action and exposure) of wildlife photographs. When the participants assessed the attractiveness of wildlife photographs, sharpness and colourfulness of the primary subjects (birds in this case) were the most

significant attributes. Specifically, the photographs with very low sharpness (definition see methodology) were avoided by participants, whereas those sharp photographs were preferred. Most participants were attracted by the two species of colourful birds (definition see methodology) rather than the two colourless birds. The colourfulness of the subject should, therefore, be an important aspect to be taken into account when considering the content of interpretation within national parks, because a colourful subject helps to attract more tourists. Within the context of integrating nature photographs into interpretive materials within national parks, the next chapter describes the evaluation of the effectiveness of interpretive signage for communication, then examines how the perceived attractiveness of photographs on the signage affects such effectiveness.

Chapter 5. The Effectiveness of the Existing Interpretive Signage within the Xixi National Wetland Park

5.1. Introduction

As reviewed in Chapter 2, effective communication of natural science stories within national parks not only improves tourists' experience of visiting but also enhance the public's understanding of science (Department of Conservation 2005; Ham & Weiler 2006; Ismail 2008; Mearns & Botha 2017). To this end, as a nonpersonal onsite interpretive product, interpretive signage that presents information about nature is widely used within such parks (Mallick & Driessen 2003; Province of Nova Scotia 2008; National Park Service 2018). Approaches to improving the effectiveness of interpretive signage are, therefore, explored by many researchers (Department of Conservation 2005; Ham & Weiler 2006; Ismail 2008; Tilden 2009). An important approach is that appropriate visualisation, such as images, should be integrated into the interpretive materials (Department of Conservation 2005; Ballantyne et al. 2006; Province of Nova Scotia 2008). As described in Section 2.4, from the perspective of science communication, the potential benefits of using images include: (i) attracting tourists' visual attention (Redi & Povoa 2013), (ii) evoking positive emotions based on aesthetic appreciation, then increasing engagement (Levie 1987; Carr 2012), (iii) improving understanding of reading and knowledge retention (Austin et al. 1995; Houts et al. 2006). In particular, photographic images have been considered as an important component of the interpretation of nature: such images can present the real status of landscape, flora and fauna, which helps visitors understand the relevant science stories better, because some of these subjects (e.g. birds and insects) are difficult to encounter and identify for the majority of tourists (Department of Conservation 2005; Caivano 2008; Husain et al. 2017).

As discussed in Section 2.4.3, the visual characteristics of a photograph may significantly affect its perceived attractiveness, which may vary the effectiveness of photographs for science communication. However, within the context of interpreting science within national

parks, there is a lack of study on the specific roles of photographs and how different types (visual characteristics) of photographs influence the effectiveness of interpretation. In Chapters 3 and 4, I identified a significant relationship between the visual characteristics and the perceived attractiveness of a photograph. Observers had positive emotional responses to those perceived appealing nature photographs. Based on my previous results in terms of photographs, this chapter focus on how photographs may influence the effectiveness of science communication through interpretive signage.

In this chapter, I aimed to test visitors' impressions of the existing signs that interpret local biodiversity within a selected Chinese national park: the Xixi National Wetland Park, then explore the potential value of photographs on the signage for interpretation. The results may provide a direction to explain how the use of photographs influences the effectiveness of the signage for interpreting natural attractions within the park. The effectiveness of the existing signage for science communication was measured by affective outcomes (the public's perceptions of the interpretive content, e.g. the attractiveness of signage) and cognitive outcomes (e.g. public understanding of the interpretive content) (Burns et al. 2003; Ham & Weiler 2006). The role of photographs was tested by its perceived appeal as well as the potential ability to affect reading experience (Jacobi & Schiele 1989; Burns et al. 2003; Macedo-Rouet et al. 2003; Dewar et al. 2007).

5.2. Methodology

5.2.1. Study area description

This study was conducted within the Xixi National Wetland Park (XNWP) near Hangzhou City, Zhejiang Province, China (for a detailed description of the study area see Section 3.2.1) from May 2017 to July 2017. Almost all the existing interpretive signs are located in the Lianhuatan birdwatching area, which is the most popular birdwatching site of the XNWP. These signs all have interpretive text and photographs relevant to the local birds and birdwatching. The site where this survey was carried out ranged from the main walk path

(from A to B, Fig. 5.1) to the area near the birdwatching hide (spot C, Fig. 5.1). This area was chosen because it contained almost all the existing interpretive signs in this hide, so as to receive responses from as many visitors as possible who had (probably) read the signage.

Fig. 5.1 The map of the XNWP. Yellow lines represent the main walking path within the park. Participants were recruited between A and B, also from B to D including C (the main birdwatching hide with interpretive signage on display, also known as the Lianhuatan birdwatching area). Source: www.google.com/earth/.

5.2.2. Survey design

The study included a field questionnaire to test visitors' impressions of the existing interpretive signs. The questionnaire consisted of four sections (for the full questionnaire see Appendix H): (i) demographic and background information, including age, gender, education, and interest in birds, (ii) visitors' general willingness to read the interpretive signage and general attitudes on the signage photographs (Items 1 to 3), (iii) if they had noticed and read the interpretive signage within the XNWP (Items 4 and 5), and (iv) if participants had read at least one interpretive sign within the XNWP, they would be invited to answer the remaining six specific questions (Item 6 to Item 11) to test whether the existing signage communicated science stories effectively, otherwise the survey ended at Item 5. The

last six specific items focused on visitors' opinions in terms of understanding, reading engagement, intention to share and remember the scientific information interpreted on the existing signage. Item 1 to Item 11 were shown in Table 5-1.

It should be noted that most of the interpretive signs are in the two-floor birdwatching hide, including a total of over 100 interpretive signs covering a number of local bird species (see Fig. 5.2). It is, therefore, difficult to test the exact extent of information retention or recall by specific questions because it is not possible to know which and how many signs each visitor had read. I then attempted to examine participants' perceptions of their information retention by the question: "*I will still remember most of the scientific facts on the signs after going back home*", which is a brief self-assessment of their intention to remember the knowledge. Even though this question is subjective, it can still test tourists' intention to remember the interpretive information to some extent. Clayman et al. (2010), for example, successfully evaluated the effectiveness of health communication between patients and their doctors by using an *Ask, Understand, Remember Assessment (AURA)* Scale, including a series of relevant self-evaluation questions, such as "*It is easy for me to remember my doctor's instructions*".

Fig. 5.2 The interpretive signage in the birdwatching hide of the XNWP. Photographer: the author.

Table 5-1 A summary of the items in the questionnaire.

Item	Statement (question)	What to test via the item
1	I always look for interpretive signs intentionally when visiting a national park like the XNWP.	General willingness to read signage within national parks
2	A good photograph on the sign always attracts me to read the information there.	General attitude towards the role of photographs
3	Interpretive signs about local natural attractions are necessary for a national park such as the XNWP.	General attitude towards the importance of signage
4	The interpretive signs in the XNWP are easy to find.	General attitude towards the location of the signage
5	The interpretive signs within this park are located in the birdwatching hide of Lianhuatan bird watching area. I have read most of these signs.	General efficacy of the existing signage
6	I feel better informed by reading the signage within the XNWP.	Knowledge gained after reading
7	Generally, the photographs on interpretive signs in the XNWP are appealing.	The perceived appeal of the photographs on the signage
8	Generally, I enjoy reading the interpretive signs within the XNWP.	Reading engagement
9	Generally, the images on signs can help me understand the text information better.	The potential link between the photos and understanding
10	I will still remember most of the scientific facts on the signs after going back home.	Intention to remember
11	I will share the scientific stories/facts I learned from the signs with friends/family.	Social support after reading

The questionnaire was approved by the University of Otago Human Ethics Committee (ID: 17/061, see Appendix A). All the participants had read the information sheet (see Appendix G) and agreed to participate before completing the questionnaire.

In addition, all the existing signage in the study area is relevant to birds. Participants' interests in birds were thus examined and grouped based on the criteria in Section 3.2.4, because such interests may affect participants' perceptions of the attractiveness of photographs and the effectiveness for interpretation (confirmed in Chapter 3). Specifically, participants were divided into three groups: (i) those have specialised interests in birds (SB), (ii) people with a general interest in birds (GB), and (iii) those who are not interested in birds (NB). Specifically, SB prefer serious bird watching, or their job or study major is directly related to birds. Thus, they have enough experience and/or good knowledge of birds (e.g.

identifying species). GB are somewhat interested in birds but do not have much relevant experience and knowledge. The NB group does not appear to care much about birds.

5.2.3. Statistical analysis and interpretations

A five-point Likert scale was applied to measure participants' attitude on each item in the questionnaire. The distribution of the data was, therefore, apparently not normal. Given the abnormalities, a Kruskal-Wallis test was applied when analysing the result of each item to examine the potential influence of interests. This non-parametric analysis is developed for abnormally distributed data and is able to compare the potential differences across more than two groups (Pallant 2013; Statistics 2015). The Statistical Product and Service Solutions (SPSS) Version 24.0 was adopted to run the statistical analysis (Pallant 2013). Results in this respect would potentially help interpret the performance of the existing signage and explore the role of photographs from the visitor's perspective.

The items in the questionnaire included an examination of both the general effectiveness of the signage and the performance of the photographs on the signage. The dimensions of the questionnaire should, therefore, be reduced to evaluate the role of photographs in science communication more efficiently. A factor analysis was thus applied to the eleven items in the questionnaire. Factors were extracted via Principal Component Analysis (PCA), but only those with eigenvalues higher than 1.0 were outputted (Lambert et al. 1990). Extracted factors reflected whether the different aspects of the effectiveness of science communication could be grouped. Also, if the use of photographs indeed played a role in the signage's effectiveness for science communication, the potential influence of participant interests in birds would be discussed together with the results of factor analysis.

5.3. Results

5.3.1. Socio-demographic summaries

A total of 511 visitors participated in the survey, including thirty-nine participants who did not complete the questionnaire (i.e. left one or more items blank). The data of these incomplete questionnaires were dropped, as they were considered as a withdrawal of participation from the survey. Participants who chose the alternative "I would rather not say/I do not know" for one or more items were included in the dataset. The usable sample size for subsequent analysis was, therefore, 472 after excluding the uncompleted questionnaires. The socio-demographic information of the participants is summarised in Fig. 5.3.

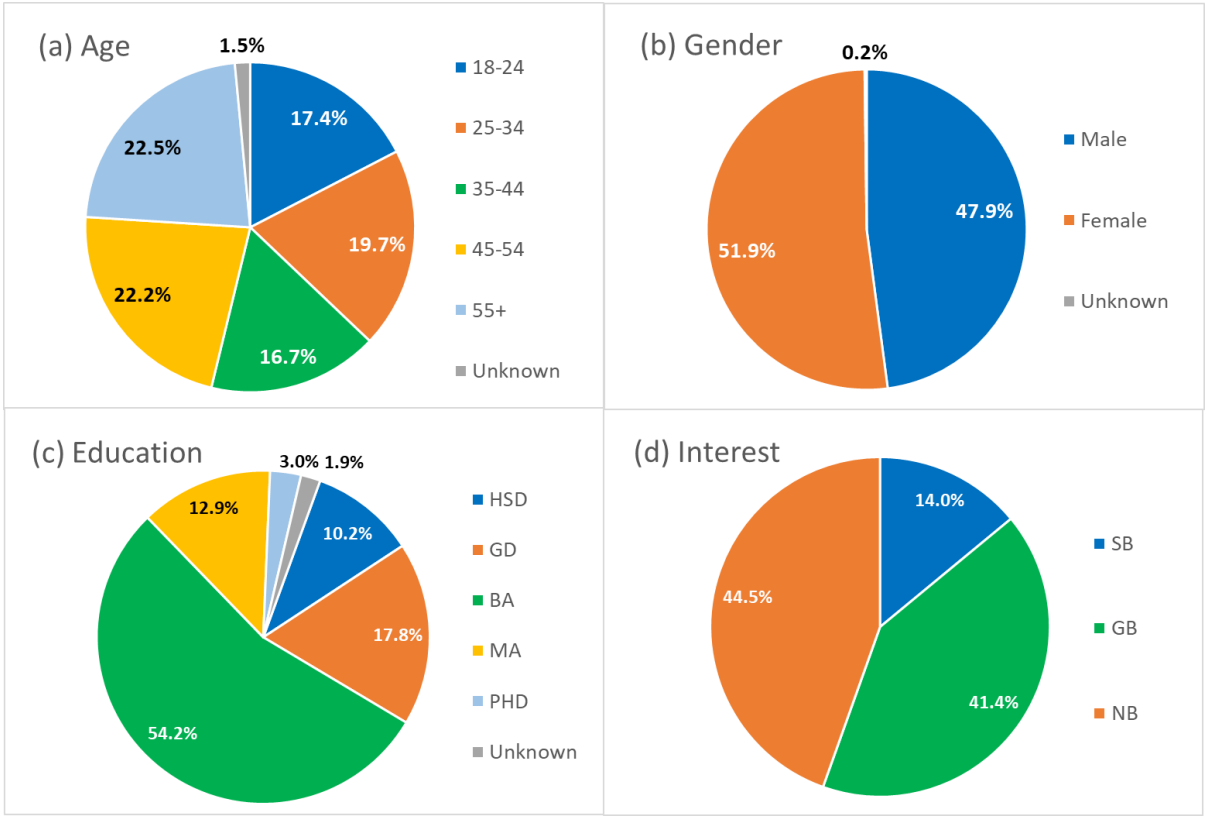


Fig. 5.3 Descriptive demographic information, n = 472. For the chart of education levels, HSD means a high school diploma or lower education levels, GD means a graduate diploma, BA means a bachelor's degree, MA means a master's degree or postgraduate diploma, and PHD means a Doctor of Philosophy. In the chart of interest groups, SB, GB and NB represent those participants who are specialised bird enthusiasts, generally interested in birds and not interested in birds, respectively. Unknown represents the option "I would rather not say/I do not know".

The socio-demographic information shows that young people (aged between eighteen and thirty-four) made up 37.1% of the total participants, which is higher than the proportion of people in the same age group in Hangzhou city (22.3%) (Bureau Hangzhou Statistical 2018). The characteristics of education levels reflected that most participants were well-educated compared to the general education level in China and in Hangzhou city (National Bureau of Statistics of China 2017; Bureau Hangzhou Statistical 2018). An explanation of the large proportion of young and well-educated respondents is that the XNWP is close to the Zhejiang University (about one kilometre), where over 50,000 students are studying (Zhejiang University 2017). The sex ratio of the sample shows that slightly more females than males participated in the survey, which is in line with the population in Hangzhou (Bureau Hangzhou Statistical 2018). With respect to the respondents' interest in birds, people with a general interest in birds (GB) and with no interest in birds (NB) accounted for 85.9% of the sample, while there were far fewer specialised bird watchers (SB) recruited.

5.3.2. Item analysis

Despite the demographic questions, another eleven items were used to test tourists' point of views on the effectiveness of existing interpretive signs for science communication within the XNWP. Participants were grouped by their interests in birds. Kruskal-Wallis test was applied to examine the influence of participants' interests in birds on their attitudes towards the existing signage. The item-based analysis is described below.

Item 1. I always look for interpretive signs intentionally when visiting a national park like the Xixi National Wetland Park.

The first item aimed to test people's general willingness to look at interpretive signage in national parks regardless of the content, quality and design of the signage. Interest was a significant factor affecting the results (Kruskal-Wallis test, $p < 0.001$). The diverging stacked bar chart below (Fig. 5.4) shows the results of this item by the three interest groups. The subsequent pairwise comparisons (Dunn's test) for interest groups show that GB had a

significantly more positive attitude than the other two groups (Dunn's test, $p < 0.001$ for comparisons between GB and NB, and between GB and SB). Generally, SB had a neutral attitude towards the interpretive signage, whereas a majority of NB tended to look for interpretive signs within a national park (Dunn's test, $p = 0.001$ for SB and NB).

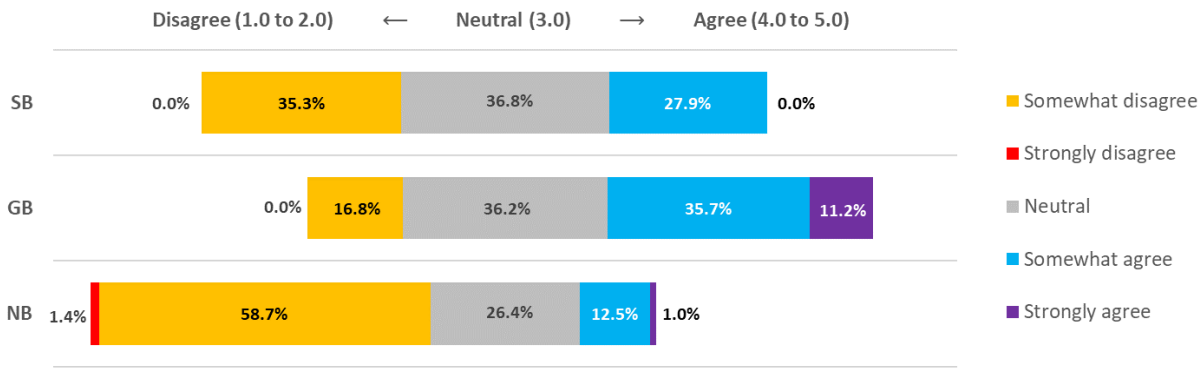


Fig. 5.4 Score frequency distribution (in percentages) of Item 1 (n = 472). Results suggest a significant influence of interests (SB, GB and NB) on the above scores. Scores include strongly disagree (1.0), somewhat disagree (2.0), neutral/neither agree nor disagree (3.0), somewhat agree (4.0) and strongly agree (5.0).

Item 2. A good photograph on the sign always attracts me to read the information there.

The second item refers to the role of photographs in interpretive signage. Fig. 5.5 illustrates clearly that the majority of participants (especially GB and NB) had a positive point of view. The scores were varied by the interests of participants (Kruskal-Wallis test, $p < 0.001$). Interestingly, more than half of SB did not strongly suggest that photographs could attract them to read an interpretive sign, and the score in this group was significantly lower than the other two groups (Dunn's test, $p < 0.001$ for both SB versus GB and SB versus NB). On the other hand, most GB and NB were engaged by an appealing photograph. For the two groups above, the responses from GB were more positive than those from NB (Dunn's test, $p = 0.005$ for GB and NB).

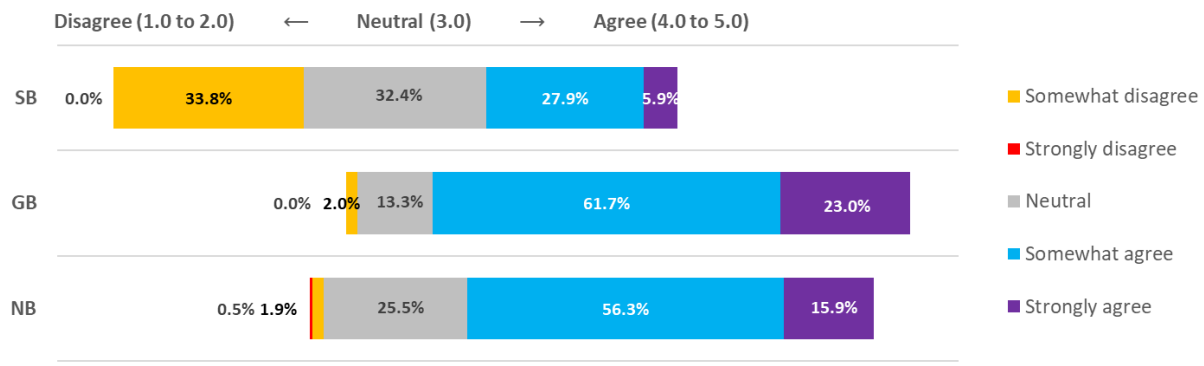


Fig. 5.5 Score frequency distribution (in percentages) of Item 2 (n = 472). Results suggest a significant influence of interests (SB, GB and NB) on the above scores. SB gave a significantly lower score for this question than the other groups of participants.

Item 3. Interpretive signs about local natural attractions are necessary for a national park such as the Xixi National Wetland Park.

With this item, I attempted to test the general importance of interpretive signs in national parks from the perspective of the visitor. As shown in Fig. 5.6, participants gave strongly positive answers to this question: 92.3% of the total 472 respondents somewhat or strongly agreed with the statement. Interests had a significant influence here (Kruskal-Wallis test, $p = 0.012$): SB had lower scores (Dunn's test, $p = 0.003$ between SL and GL), even though a majority of SB still recognised the importance of interpretive signage. This item reflects that the use of interpretive signage has the support of the general public regardless of their interest in the relevant topic.

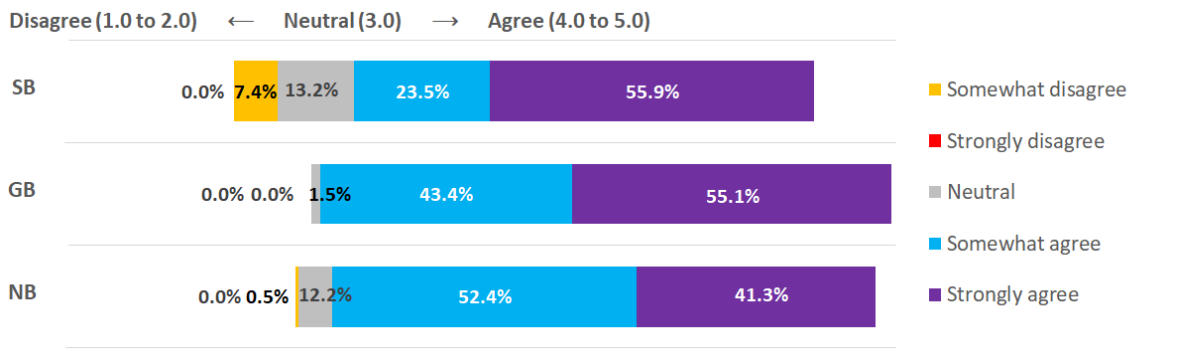


Fig. 5.6 Score frequency distribution (in percentages) of Item 3 (n = 472). Results suggest a significant influence of interests (SB, GB and NB) on the above scores.

Item 4. The interpretive signs in the Xixi National Wetland Park are easy to find.

The aim of Item 4 was to check whether visitors were satisfied with the locations of the interpretive signs. The answer was apparently negative (Fig. 5.7). A total of 76.5% of the respondents claimed that the interpretive signs should be easier to find (scores lower than 3.0). Item scores did not differ among interest groups (Kruskal-Wallis test, $p = 0.304$).

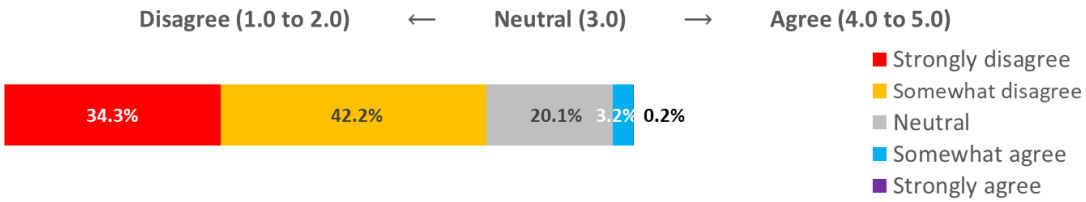


Fig. 5.7 Score frequency distribution (in percentages) of Item 4 (n = 472).

Item 5. The interpretive signs within this park are located in the birdwatching hide of the Lianhuatan bird watching area. I have read most of these signs.

This item tested if participants had the experience of reading the existing interpretive signage within the XNWP and the brief amount of the signage that they had been read. Results show that 206 (43.6% of total) participants had read at least one interpretive sign within the park, and thus completed the remaining six specific questions about the effectiveness of the existing signage. As illustrated in Fig. 5.8, responses were significantly affected by interest (Kruskal-Wallis test, $p < 0.001$). Pairwise comparisons all gave significant results between any two groups (Dunn's test $p < 0.001$). Specifically, SB gave more positive responses than the other two groups, whereas most NB (75.5%) did not notice there were interpretive signs within the park at all.

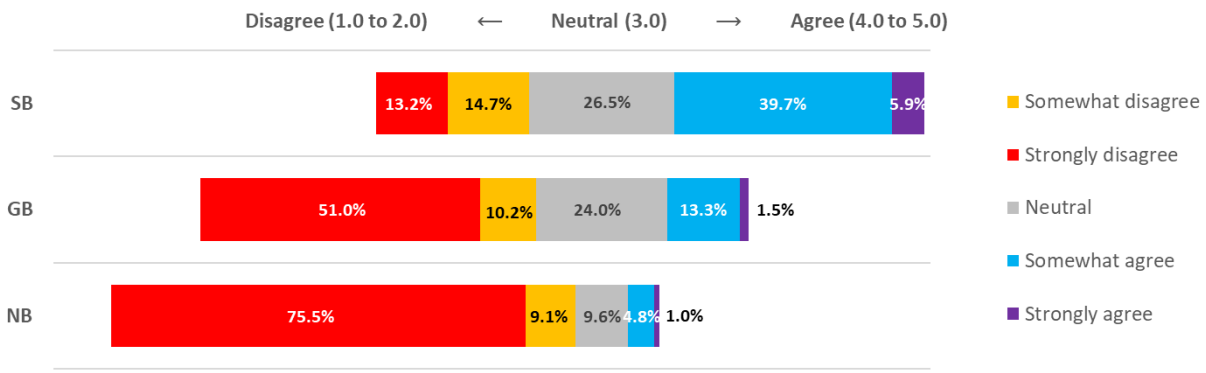


Fig. 5.8 Score frequency distribution (in percentages) of Item 5 (n = 472). Results suggest a significant influence of interests (SB, GB and NB) on the above scores. It should be noted that the alternative *strongly disagree* means the participant had not read any existing signage (also noted in the questionnaire sheet).

The following six questions from Item 6 to Item 10 focused on visitors' evaluation of the effectiveness of the existing signage for interpreting biodiversity information. Therefore, only the participants who had read those signs were involved. The sample size of the following items is, therefore, 206.

Item 6. I feel better informed by reading the signage within the Xixi National Wetland Park.

Item 6 concentrated on visitors' attitude towards the signage's textual content. Respondents generally had positive attitudes in this respect (Fig. 5.9). The Kruskal-Wallis test did not find any significant relationship between the scores for this item and the interests of respondents (Kruskal-Wallis test, p = 0.478).

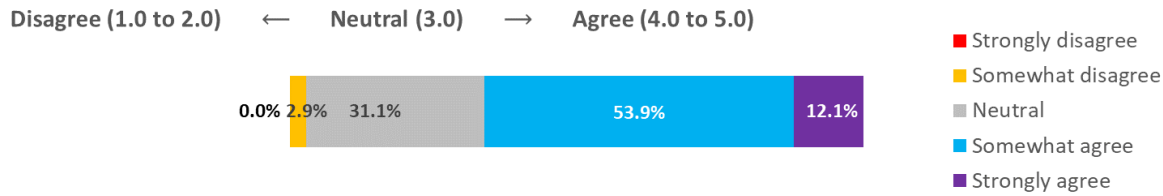


Fig. 5.9 Score frequency distribution (in percentages) of Item 6 (n = 206).

Item 7. Generally, the photographs on interpretive signs in the Xixi National Wetland Park are appealing.

Item 7 tested the general attractiveness of photographs on the existing signage. The distribution of score frequencies of this item was generally neutral. However, participants' interests in birds significantly affected their evaluations of the appealing of photographs (Kruskal-Wallis test, $p < 0.001$, see Fig. 5.10). Surprisingly, SB disliked the photographs (Dunn's test, $p < 0.001$ between SB and GB, as well as between SB and NB). On the other hand, the remaining participants (GB and NB) thought the photographs were generally appealing, and significant differences were not found between the scores of GB and NB (Dunn's test, $p = 0.627$). A birdwatcher (SB) left the following comment after completing the questionnaire: "*The photographs on the signage really sucks, with a lot of blurry photographs and even the misidentified species of birds" (Participant 303)*".

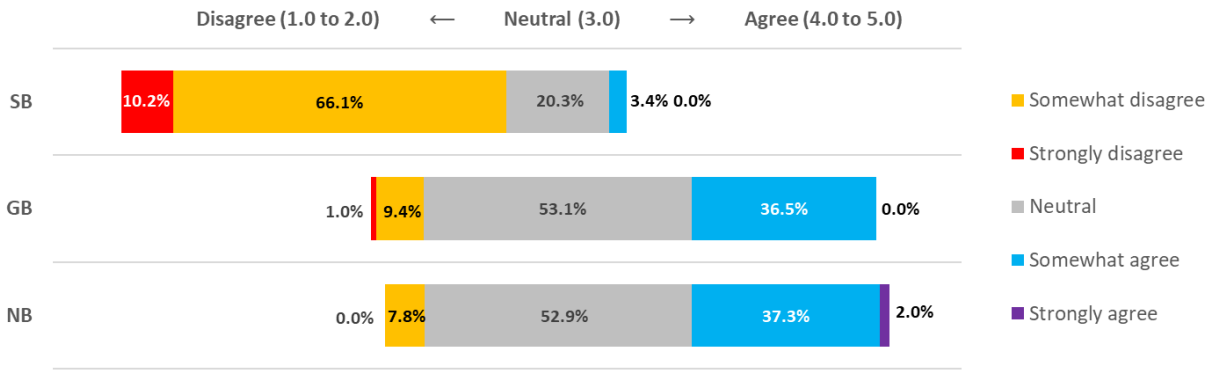


Fig. 5.10 Visitors' evaluation of the visual appeal of the photographs on existing signs within the XNWP (Item 7, n = 206). Results suggest a significant influence of interests (SB, GB and NB) on the above scores.

Item 8. Generally, I enjoy reading the interpretive signs within the Xixi National Wetland Park.

Reading engagement can also be reflected by this item. Results show that only 7.8% of all the respondents had a positive experience reading the existing signs within the XNWP (scored 4 or 5, i.e. somewhat or strongly agreed). The scores were also affected by interest levels (Kruskal-Wallis test, $p < 0.001$, see Fig. 5.11). SB gave extremely low scores for this

question – significantly lower than respondents with a general or no interest in birds (Dunn's test, $p < 0.001$ between SB and GB, and between SB and NB), while there was no significant difference between the scores of GB and NB (Dunn's test, $p = 0.148$).

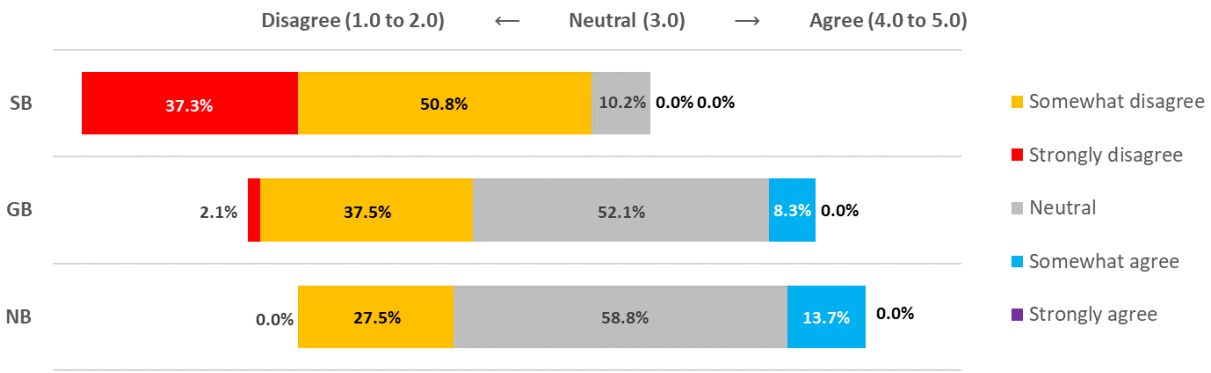


Fig. 5.11 Enjoyment of reading the existing signs within the XNWP (Item 8, n = 206). Results suggest a significant influence of interests (SB, GB and NB) on the above scores.

Item 9. Generally, the images on signs can help me understand the text information better.

This item focused on the relationship between the photographs and understanding the textual content on the signage. Participants' interests in birds gave the scores significantly different distributions (Kruskal-Wallis test, $p = 0.001$, see Fig. 5.12). The responses from GB and NB were generally positive and did not show any significant difference (Dunn's test, $p = 0.765$ for GB and NB); the attitude of SB, however, was much more negative (Dunn's test, $p < 0.001$ between SB and GB, and $p = 0.001$ between SB and NB).

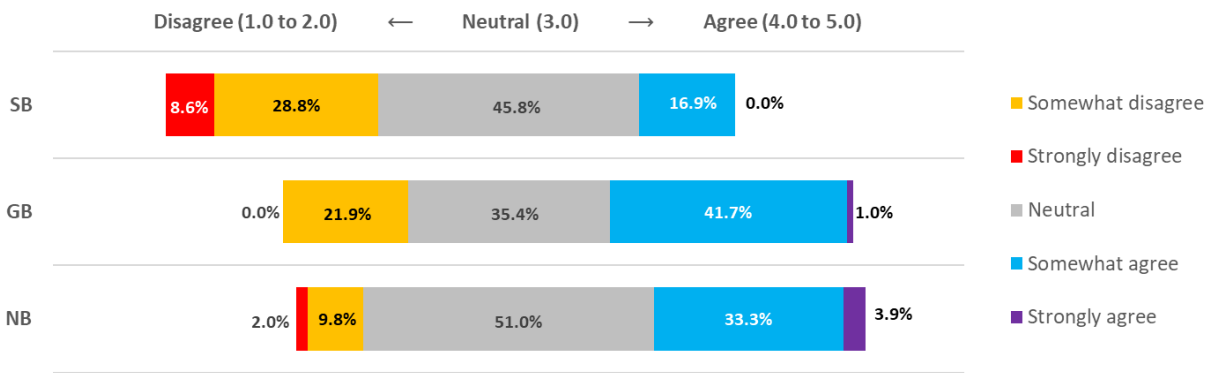


Fig. 5.12 Whether or to what extent the images improved understanding (Item 9, n = 206). Results suggest a significant influence of interests (SB, GB and NB) on the above scores.

Item 10. I will still remember most of the scientific stories/facts on the signs after going back home.

The aim of Item 10 was to estimate the intention to memorise the content on the signage through self-evaluation. Self-evaluation is an important aspect of evaluating the effectiveness of signs for science communication (Clayman et al. 2010). Surprisingly, as shown in Fig. 5.13, only a small proportion (8.3%) of participants gave positive answers to this item, reflecting a negative attitude towards the effectiveness of the signs for the purpose of science communication. In addition, interest groups did not have a significant influence on the scores for this item (Kruskal-Wallis test, $p = 0.124$).

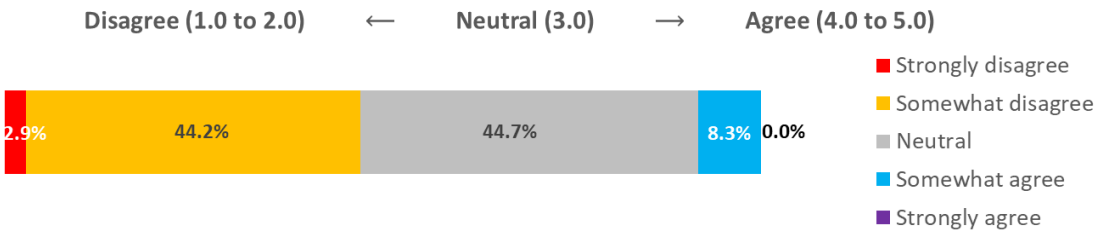


Fig. 5.13 Score frequency distribution (in percentages) of Item 10 (n = 206).

Item 11. I will share the scientific stories/facts I learned from the signs with friends/family.

This item examined the willingness to share the information interpreted by the signs (e.g. public support). Participants generally showed a negative attitude to this item, with only 5.4% of all the participants giving positive answers. Participants' interests in birds influenced the scores significantly (Kruskal-Wallis test, $p = 0.001$, see Fig. 5.14). Pairwise comparisons revealed that SB had the least willingness to share the information on the signage. Their scores were significantly lower than the scores of GB and NB. (Dunn's test, $p < 0.001$ for SB and GB, and $p = 0.043$ for SB and NB). There was no significant difference between the scores of GB and NB (Dunn's test, $p = 0.206$).

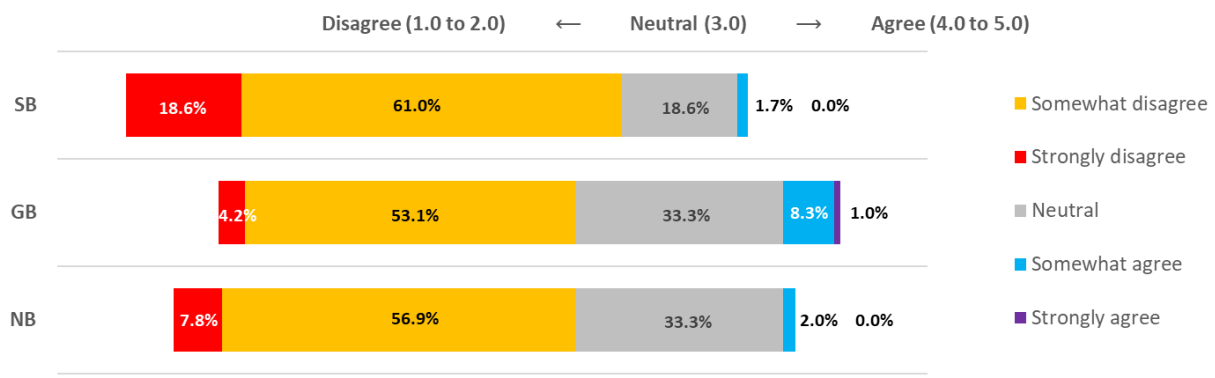


Fig. 5.14 Score frequency distribution (in percentages) of Item 11 (n = 206). Results suggest a significant influence of interests (SB, GB and NB) on the above scores.

5.3.3. The role of photographic elements in the existing interpretive signage within the XNWP

An exploratory factor analysis was applied to explore the potential influence of the participants' evaluation of the photographs on their reading experience. The results also reflected different dimensions of evaluating the effectiveness of communicating scientific information about nature. The eleven items about participants' perceptions of the existing signage were used as variables in the factor analysis, and the sample size was 201, which was the number of visitors who had completed all eleven items.

A total of three factors were eventually extracted and taken into the subsequent interpretation, covering a total of 53.0% of the variance. Ten out of the eleven items were significantly loaded onto the three factors. Factors were extracted via a principal components analysis (PCA). The factors were then varimax rotated so that they could be better interpreted (Pallant 2013). Table 5-2 summarises the results of factor analysis. The three factors were named as photograph-related effectiveness, gaining knowledge, and general attitude towards interpretive signage.

Table 5-2 A summary of the results of factor analysis (factor extraction method: PCA, rotation method: Varimax with Kaiser normalisation), showing visitors' perceptions of the effectiveness of the existing signs in science communication. Items are questions in the questionnaire. The proportions that a factor explains for the total variance are given (see the description of each factor). The values of factor loadings represent the weight of each factor on a certain item. The three extracted factors reflect different aspects in terms of science communication.

Factor	Description of the factor	Item	Brief description of the item	Loading
I	Photograph-related effectiveness 23.7%	Item 2	General attitude towards the role of photographs	0.728
		Item 7	The perceived appeal of the photographs on the signage	0.763
		Item 8	Reading engagement	0.798
		Item 9	The potential link between the photos and understanding	0.626
II	Gaining knowledge 17.5%	Item 5	General efficacy of the existing signage	0.629
		Item 6	Knowledge gained after reading	0.599
		Item 10	Knowledge retain after reading (self-evaluation)	0.660
		Item 11	Social support after reading the existing signage	0.599
III	General attitude towards interpretive signage 11.8%	Item 1	General willingness to read signage in national parks	0.774
		Item 3	General attitude towards the importance of interpretive signage	0.730

Factor 1: Photograph-related Effectiveness

As shown in Table 5-2, the photograph-related effectiveness was the most important factor when assessing the effectiveness of the signage for science communication, explaining 23.7% of the total variance. The general and specific questions about participants' perceptions of the photographs on the signage (Item 2 and Item 7) were loaded onto this factor. Factor 1 was also related to the reading experience, including understanding and engagement (Item 8 and Item 9). The four items loaded on Factor 1 positively correlated with each other (Pearson's correlation, based on the correlation matrix, $p < 0.001$), suggesting that an appealing photograph on the signage is likely to attract a majority the visitors, and enhance their reading experience in terms of understanding and engagement.

Also, a significant positive link between the visitors' attitude towards the importance of photographs for signage (Item 2) and their evaluations of the quality of photographs on the

existing signs (Item 7) was found within Factor 1 (Pearson's $r = 0.51$, $p < 0.001$). However, it should be noted that even though there is a significant link, it still cannot provide sufficient evidence that if visitors felt more easily attracted to a sign with an appealing photograph, then they would give a more positive evaluation of the visual quality of the photographs on the existing signage within the XNWP generally. This is because: (i) factor analysis can only show the correlations between variables (items) instead of causality (Harman 1976; Rubenstein 1986), (ii) as discussed already, there is a lack of specifically targeted signs with systematically assessed photographs in this chapter, suggesting that the evaluation of photographic quality by participants (Item 7) may be subjective and unclear, and (iii) the variance has probably been influenced by the interest groups more than the gradient of the visual quality.

As referred to above, participants' interest in birds (SB, GB or NB) also plays a role in Factor 1. Specifically, all the four items loaded here are significantly influenced by interest (detail see item analysis). Those participants with a general interest in birds (GB) and with no interest in birds (NB) had similar and positive scores for these four items, especially for Item 7, the quality assessment of photographs. Most of the specialised bird enthusiasts (SB), however, gave neutral or negative responses. In other words, SB claimed that the quality of photographs on existing signage was poor, and signs with such photographs would not improve their reading experience.

Factor 2: Gaining Knowledge

Factor 2 also has four items loaded, including Item 5 (the relative amount of the existing signage that had been read by participants), Item 6 and Item 10 (knowledge gain and retention, self-evaluation), as well as Item 11 (social support after reading the existing signage). Among them, Item 5 briefly reflects the number of signs that the participants have read, which is positively correlated with participants' self-evaluation of knowledge gain, as well as knowledge retention and subsequent social support (information sharing). However, the correlations between Items 5 and 10, as well as Items 5 and 11, are relatively weak

(Pearson's r = 0.27 for the former, r = 0.1 for the latter), suggesting that even though the visitors read a good number of signs, their knowledge retention (self-evaluation) and willingness for social support did not increase to the same extent. This factor, as an important aspect of the effectiveness of signage for communication, is therefore named as *Gaining knowledge* as all the three specific items focus on the scientific facts (text) interpreted by the signage rather than the photographs.

Factor 3: General Attitude towards Interpretive Signage

Factor 3 only includes the two general questions (Item 1 and Item 3) that tested visitors' general willingness and attitudes towards the interpretive signage in national parks. This factor, as well as the significant relationship between the two items, represents that the more important one thinks a sign is, the higher the motivation he/she may have to read the sign. In other words, interpretive signs are more likely to be read when people have a positive attitude to signs. This factor emphasises the influence of people's perception of the interpretive signage on the effectiveness of the signage to interpret science stories. This finding also reflects the importance of using high-quality photographs because it helps to develop tourists' positive attitude towards interpretive signage.

5.4. Discussion

5.4.1. The performance of the existing signage within the XNWP

The aims of this chapter are to examine the performance of the existing interpretive signage in terms of science communication and to explore whether the photographs on the signage can influence the effectiveness of interpretive signage. Results suggest that the existing interpretive signs within the XNWP indeed attracted a few visitor's attention. However, tourists' perceptions and evaluations of the interpretive signage within the XNWP are affected by their interests in birds. Even though most SB recognised the importance of interpretive signage for a national park (Item 3), but they did not tend to use them (Item 1).

An explanation is that SB have a high self-evaluation with regard to their knowledge of birds and feel that they already have the knowledge provided by the interpretive signage (Maple et al. 2010).

Regarding the effectiveness of the existing signage, SB left negative evaluations of the photographs on the signage (Item 7) and claimed that they did not enjoy reading (Item 8). These participants also pointed out that the photographs on the signage did not help to improve understanding (Item 9). In contrast, GB and NB who had read the signage gave a more positive response. An explanation is that most birdwatchers have already seen (or taken) a number of high-quality photographs via bird books (e.g. photographic field guide to local birds), social media (e.g. birdwatching websites or online group chats), and their birdwatcher friends (McFarlane & Boxall 1996; Maple et al. 2010). With enough knowledge about birds and experience in birdwatching and wildlife photography (Maple et al. 2010; Lebreton et al. 2016), knowledgeable SB are able to provide more pointed and critical feedback, whereas GB and NB groups do not have the specialised knowledge to be able to offer contrary opinions about the signs. Similarly, a study of people's perception of the photography's aesthetic appeal found that the participants who spent a large amount of money on photography (i.e. knowledgeable or experienced photographers) gave significantly lower aesthetic scores for a photograph than the others (Lebreton et al. 2016). In summary, individuals' prior knowledge of the subject (e.g. bird) is closely related to their aesthetic appreciation, thus influencing the effectiveness of interpretive materials.

5.4.2. The role of photographs in interpretive signage for science communication

The evaluation of the effectiveness of science communication is a complex process, involving different aspects such as engaging, understanding and supporting, for details see the review in Section 2.4.1 (Burns et al. 2003). In the context of the existing signage within the XNWP, the factor analysis presents distinctive results to examine the performance of the signage in science communication from two aspects based on visitors' reading experience:

photograph-related effectiveness (Factor 1), and knowledge gained on the basis of the text information (Factor 2).

The first factor is related to the appearance and the perceived visual appeal of the photographs selected. A potential link can be found through this factor: if tourists think the photograph on an interpretive sign is appealing, they may tend to read the sign and may have higher reading engagement. An appealing photograph can also enhance visitors' understanding of the text. The findings are generally in line with Betts and McNaughton (2003), who showed that adding appealing images can make students better enjoy and understand mathematics lessons. However, participants' interests in birds significantly influence the importance of the visual quality of photographs for them: those GB and NB tend to be attracted by the interpretive signage with an outstanding photograph, whereas SB are less likely to be impressed by such signs (for details see Item 2). The results are in line with the findings in Chapter 3: when evaluating the perceived attractiveness of a photograph of a bird, the visual quality of the photograph is the most important factor for GB and NB, while SB mainly focus on the biological, ecological and behavioural characteristics of the subject rather than the overall quality of the photograph.

In this chapter, I tested participants' perception of the visual appeal of the photographs on the signage through Item 7. The score of this item is highly varied from extremely negative to positive, even though all the signage referred to here is located in the same birdwatching hide. This is probably because: (i) participants have a different point of views about the quality of the photographs, because the evaluation of photographic quality is complicated (Aydın et al. 2015), depending sometimes on observers' personalised aesthetic preferences (Marchesotti et al. 2011; Vessel et al. 2014), (ii) the content of all the existing interpretive signage within the XNWP is about local birds. However, different species of birds have varied attractiveness to visitors based on their taxa, morphological traits, and colour diversity (Frynta et al. 2010; Lišková & Frynta 2013), see also the results in Chapter 3, and (iii) there is a significant influence of participants' interests in birds on their attitude towards the photographs on the existing signage. SB tended to judge the general quality of photographs

with a much more critical attitude as did GB and NB. As discussed above (Section 5.4.1), bird enthusiasts (SB) are experienced and knowledgeable, which results in more stringent criteria when judging the perceived attractiveness of a photograph of birds. Therefore, the comments and criticisms from SB are important because they can find the potential weaknesses in the interpretive content (both text and photographs) that were ignored by GB and NB. For example, in Chapter 3, SB pointed out that they prefer locally representative birds. Unique or other attractive actions in a photograph of birds were also attractive to SB. The finding above provides an important guidance for improving the effectiveness of the interpretation of natural science stories, especially in terms of the selection of appropriate photographs.

5.4.3. Gaining knowledge: content-based effectiveness of science communication

Apart from the photograph-based effectiveness, another important factor that reflects the effectiveness of interpretive signage for communication is participants' evaluations of the textual content (Factor 2 in the factor analysis section) in terms of gaining knowledge. According to the results of the factor analysis, participants' point of views on knowledge gain and retention (Item 6 and Item 10), as well as the relevant social support after reading (Item 11), were positively influenced by the amount of signage they had read (Item 5) and did not show any noticeable interest-related difference. However, a majority of participants recognised that they felt informed after reading the signage, but they did not think they would remember the content of the signage or carry out any relevant social support (e.g. sharing the information). Such a negative self-evaluation of knowledge retention coincides with Ballantyne et al. (2011), who explored the relationship between wildlife tours and tourists' reflective response, claiming that tourists' impressions of the tour did not depend much on the interpretive materials (talk and signage) during the tour. In their study, participants stated that they could hardly remember the factual information interpreted by the talk and the signage. Such findings reflect that the effectiveness of interpretive content still has room to improve. Here, storytelling, as a powerful tool for science communication, becomes a

suggested approach to enhance the attractiveness and effectiveness of the textual interpretive content (Dahlstrom 2014). Because interpreting science by a story helps to attract more audience and form long-lasting memories (knowledge retention) (Nigro & Trivelato 2012; Negrete 2014). The above benefits are reflected by Factor 2 in this study, which suggests that visitors' attitudes towards the attractiveness of the textual information are related to knowledge retention.

However, it should be noted that participants' performance of knowledge retention is based on a single self-assessment item in this study rather than any empirical tests on knowledge gain or recall. Further studies are, therefore, encouraged to: (i) explore the relationship between the photographs and knowledge retention in a more manipulated condition (conducted in Chapter 6), and (ii) develop the use of storytelling to enhance the effectiveness of interpretive signage within national parks.

5.5. Conclusion and implications

The focus of this chapter is on the effectiveness of the existing interpretive signage within the XNWP, especially the role of the photographs used on the signage. Participants' responses clearly show that the effectiveness of signage to communicate science is varied based on a significant interest-related pattern. Specifically, only a minority of visitors with a general and no interest in birds (GB and NB respectively) had read the signage. These GB and NB who had read the signage gave generally positive evaluations of the visual quality of photographs and suggested a positive reading experience. In contrast, bird enthusiast (SB), though most of them had read the signage, claimed that they did not enjoy reading it and the photographs were of poor quality. Regardless of the interest groups, most participants thought they were better informed after reading the existing signage, but they were not confident in their knowledge retention and did not think they would carry out relevant social support such as sharing information acquired from the signage. The knowledge and experience of these specialised enthusiasts play a significant role here.

In addition, the present study developed two dimensions to gauge the effectiveness of signage (with photographs) for communicating stories about nature. The first is the photograph-related effectiveness, which reflects the positive link between the perceived visual attractiveness of photographs on the signage and these two aspects of the effectiveness of science communication: engagement and understanding. The second dimension focuses on knowledge gain based on the textual content of the signage; specifically, the more signage the visitors read, the better they will think they are informed. The items loaded onto this factor reflect that storytelling is a potentially powerful tool to improve the performance of interpretive textual content for science communication. It can be concluded that the photograph indeed plays an important role in interpretive signage for science communication. A variety of positive responses in terms of the experience of reading the signage correlates closely with the perceived visual appeal of photographs. Further study is needed to clarify the role of photographs for visitor attention and recall of the information interpreted by the signage.

This study suggests a direction for assessing the role of photographs in interpretive signage. However, the textual content and the aesthetic appeal of photographs on the existing signage in the XNWP (more than 100) are varied as they have not been manipulated. Therefore, participants' perceptions of appealing and poor photographs (see Item 7) are general and subjective. In order to better clarify the specific values of photographs for science communication, the next chapter investigates the roles of photographs for enhancing the communication of science stories within national parks under a manipulated experimental condition.

Chapter 6. The Effectiveness of Photographs to Communicate Nature Stories through Interpretive Signage

6.1. Introduction

National parks are appropriate locations to communicate nature stories and build human-nature connections (for details see Chapter 2). Effective interpretation of natural attractions within such parks is an important means to improve tourists' experience of visiting and increase their knowledge of natural science (Department of Conservation 2005). Aiming to communicate natural science stories more effective, I focus on the use of photographs to enhance the effectiveness of communication in this thesis.

The results in Chapter 3 showed that an appealing photograph could draw the observer's attention. Therefore, the relationship between the attractiveness of a photograph and visitors' attention to the interpretive product that uses this photograph is worth exploring. To support this, using eye-tracking technology, Slykhuis et al. (2005) have proven that a photograph helps to draw students' attention when doing science education through slides. In the field of health communication, Houts et al. (2006) suggest that using a picture increases patients' attention to interpretive information. However, as described in Section 2.4.3, photographs, as a form of the creative visual arts, have different visual characteristics (e.g. subject and visual quality), which significantly influence its visual appeal (see Chapters 3 and 4). Such characteristics of photographs may also affect their efficacy when using photographs to communicate science. Unfortunately, there appear to be no studies focusing on how the visual characteristics of a photograph affect its effectiveness to interpret science stories within national parks.

The previous chapter (Chapter 5) reported a preliminary study on the potential influence of photographs on the effectiveness of the existing interpretive signage within a Chinese national park. Results suggested that if tourists thought the photographs on the signage were

appealing, they would have a better experience of reading. However, due to the varied and uncontrolled visual characteristics of photographs on the existing signage, it is difficult to generalise the finding above. Thus, with the manipulated interpretive signage within a national park, this chapter explores: (i) does the use of a photograph on the interpretive signage help to enhance the effectiveness of science communication? (ii) how does the visual appeal of a photograph influence the effectiveness of interpretive signage for communication?

In this chapter, I manipulated the visual appeal of photographs through using photographs of the same subject but different visual qualities on the experimental signage, so that the implications of photographs on different signs could be compared. Based on the results in Chapter 5 and suggestions from Burns et al. (2003), Ham and Weiler (2006), the effectiveness of the interpretive signage for communication was measured by affective outcomes (e.g. general attractiveness and reading engagement) and cognitive outcomes (e.g. understanding and recall of knowledge) (Burns et al. 2003; Ham & Weiler 2006; Tilden 2009). In addition, given that WeChat articles are a potentially powerful interpretive approach to communicating science stories (see Section 2.5.2), the QR codes that contain the links of such articles have been integrated into the interpretive materials (e.g. signage) within a few natural areas in China (for the use of QR codes see Section 2.6) (Liu et al. 2015). Therefore, visitors' intention to scan the QR code on the signage to acquire further information in WeChat articles was also considered as an aspect of the effectiveness of science communication in this chapter.

6.2. Methodology

6.2.1. The design of the manipulated interpretive signage

This study was conducted within the Xixi National Wetland Park (XNWP), which is the same study area of Chapter 3 and Chapter 5, described in Section 3.2.1. The content (layout, text and image) of the interpretive signage as the experiment material was carefully manipulated so as to make it possible to analyse the influence of a single element (i.e.

photograph) on the effectiveness of the signage for communication. A total of three manipulated interpretive signs were, therefore, set up within the XNWP. Photographs with different visual appeals were integrated onto manipulated signs, and all the other elements (layout and textual information) on the signage were the same.

The scientific content interpreted by the manipulated signs was a brief introduction of the Common Kingfisher (*Alcedo atthis*). This bird species had been chosen as the topic because it is one of the most common, wide-spread and famous wetland birds in China (Zhao 2001a). Also, the Common Kingfishers are abundant in the XNWP, and their remarkable shining plumage made it easy to be identified. However, a Common Kingfisher is still not that easy to be spotted in the wild as its body size is small, ranging from 150 to 180 millimetres (Zhao 2001a). Unless one is a birdwatcher who is looking for birds on purpose, most general tourists are not likely to notice this bird. Additionally, the detail of its plumage colours, as well as its behavioural and ecological traits are not known by most people. Such a knowledge gap made the Common Kingfisher an ideal species for this experiment.

With the same text information of the Common Kingfisher being interpreted, three variants of the manipulated signs were set up successively during the field survey. There were three sections of the text information on each sign. The first section was a general introduction to the Common Kingfisher, including taxonomy, plumage colours, distribution, habitat and so forth. The second section was "*Six Interesting Facts about a Common Kingfisher*," which interpreted some of the unique morphological and behavioural characteristics of this species. The last section pointed out the relationship between Common Kingfishers and the wetland conservation from ecological and conservational perspectives. Apart from the scientific name of the bird, all the textual information was presented in Chinese. All the three manipulated signs presented a QR code which contains the link of an interpretive WeChat Public Account article about the Common Kingfisher. If tourists were interested in the content, they might scan the QR code by their smartphones and read further stories (Liu et al. 2008; Liu et al. 2015).

The visual appeal of the photographs involved in this experiment was manipulated based on their visual quality (measured by aesthetic value here), because for the majority of observers, the visual quality was the most important factor that influences the visual appeal of a photograph with natural subjects (for details see Chapter 3). Different qualities of photographs of the Common Kingfisher were shown at the same place on the three signs. Specifically, a high-quality photograph of the Common Kingfisher was organised on the first sign (Fig. 6.1a), while the second sign appeared with a poor-quality photograph of Common Kingfisher (Fig. 6.1b). As a control, instead of photographs, there was a logo of the XNWP appearing on the third manipulation (Fig. 6.1c).

Fig. 6.1 Three manipulated interpretive signage for the survey in the XNWP: the signage with a high-quality photograph (a), with a poor-quality photograph (b) and the control group without a photograph (c).

The visual qualities of the selected photographs were measured based on the aesthetic scores by an online application: Acquine (Datta & Wang 2010). This website-based application measures the aesthetics of images based on a combination of computational aesthetic

assessment and the judgement from human observers Datta et al. (2006) and Datta and Wang (2010). According to the scores by produced by Acquine, the high-quality photograph of the Common Kingfisher was given an aesthetic score of 8.9 out of 10.0 while the score of the poor-quality one was 4.6, reflecting a noticeable difference in visual quality. Photographs were selected and downloaded from www.flickr.com based on a Creative Commons (CC) Licence (Creative Commons 2017), the details of the licence were given in Table 6-1.

Table 6-1 Aesthetics and copyright information of the selected photographs.

Photograph	Acquine Score	Author	URL	Creative Commons Licence
High-quality	8.9	Martha de Jong-Lantink	goo.gl/KpYSif	CC BY-NC-ND 2.0
Poor-quality	4.6	Charles Lam	goo.gl/ZlNvbT	CC BY-SA 2.0

6.2.2. The design of the survey

The entire period of field survey was divided evenly into three sections conducted at approximately the same area (south of the main walk path in the XNWP), only one of the three manipulated signs was displayed during each section. Each section included a field observation on tourists' willingness to read the signage as well as a questionnaire survey, testing the effectiveness of the manipulated signage to communicate science. The fieldwork was conducted from June 2017 to July 2017.

The observation focused on the attractiveness of the signage to visitors: when the signage is set up, whether visitors would like to stop to read the sign? During the period of observation, I stood approximately fifteen to thirty metres away from the sign and recorded whether a pedestrian stopped to read the sign (i.e. stood still and looked at the signage) or just passed over. The number of tourists who not only read the signage but also scanned the QR code on it was also recorded. When observing the visitors, I did not say or do anything that potentially attracted visitors' attention. Therefore, the only reason that might make visitors stop was the signage itself. The results were recorded as the frequency (i.e. the number of people) of stops, scans and passing under different experimental conditions (i.e. different signage). The total

hours of the observation under the three conditions were the same so that the frequencies of stops for the three experiments were comparable.

The questionnaire survey was used to examine the specific role of photographs in the reading experience and post-reading response. According to the research aims of this chapter, the questionnaire included three sections in total (the full questionnaire was presented in Appendix J). The first section had a series of socio-demographic items about age, gender and education as well as participants' interests in birds. The second section examined the effectiveness of the signage for science communication (Ham & Weiler 2006), as well as participants' prior knowledge of the theme interpreted (Items 1 to Item 10, see Table 6-2). As the content interpreted on the manipulated signage was introductory information, the focused outcomes of science communication were affective and cognitive aspects (i.e. changes in interest, emotion and/or relevant knowledge) rather than behavioural aspects (i.e. behavioural changes). Some of the items testing comprehension, engagement and supports were developed from Burns et al. (2003) and Macedo-Rouet et al. (2003), while others were designed based on the elements and detailed content of the scientific information (the factual story about Common Kingfisher on the signage). A 5-point Likert scale (from strongly disagree to strongly agree) was applied to describe participants' perceptions of the statement for each item.

Table 6-2 A summary of the items in the questionnaire.

Item	Statement (question)	What to test via the item
1	I enjoy reading this sign.	Reading engagement
2	The interpretive text information on this sign is attractive.	Attractiveness of the textual element
3	The image used on the sign is appealing.	Attractiveness of the image
4	I feel better informed by reading this sign.	Knowledge gained (self-evaluated)
5	The material increases my interest in the topic (i.e. birds).	Interest enhanced
6	I will share the scientific stories/facts I learned from this sign with friends/family.	Intention to share

Item	Statement (question)	What to test via the item
7	I have known most of the scientific matters interpreted by the sign already before reading.	Prior knowledge
8	I am clear about the meanings of the ornithological concepts referred to in the text on this sign.	Concepts comprehension
9	The image on this sign can help me understand the text information better.	Influence of the image on the understanding of reading
10	If the researcher did not ask me to read the interpretive sign and complete this questionnaire, I would still like to stop to read it.	Willingness to read (self-evaluated)

The last section of the questionnaire (Items 11 to 18) was a short knowledge test on the scientific information interpreted by the signage. This knowledge test section included eight questions covering the visual traits (four questions), and behavioural traits (four questions) of the Common Kingfisher (see the visual and behavioural group in Table 6-3), all of which had been mentioned in the textual information on the signage. While the tested visual traits were also presented in the photographs (both high-quality and poor-quality photographs) on the signage, however, it should be noted that there was no photograph for the control group. When participants were completing this section, the signage was turned over, the participants were, thereby, not able to read the signage during this period.

Table 6-3 Questions in the knowledge test section. In the Group column, *Behavioural* means the questions of behavioural and ecological traits, while *Visual* means the questions regarding visual traits. Answers to questions in the Visual group were all revealed in both text and photograph on the sign (even for the low-quality photo), whereas answers to behavioural questions could only be found in the text paragraphs on the sign. All the questions in the section were multiple-choice questions. There were four alternatives for each question (including "I do not know"), but only one was correct. Participants' responses to each item were measured binomial: 0 (wrong) or 1 (correct).

Item	Group	Question	Score
11	Behavioural	Where does a Common Kingfisher usually live?	0 or 1
12	Behavioural	Can a Common Kingfisher survive in the winter of north China	0 or 1
13	Visual	A Common Kingfisher has an orange lower bill. Is it a male or a female?	0 or 1
14	Visual	What is the colour of feathers on the throat of a Common Kingfisher?	0 or 1
15	Visual	What is the colour of feathers on the belly of a Common Kingfisher?	0 or 1
16	Behavioural	What is the courtship behaviour of a male Common Kingfisher?	0 or 1
17	Behavioural	Where does a Common Kingfisher build a nest?	0 or 1
18	Visual	What is the colour on the feet of a Common Kingfisher?	0 or 1

As shown in Table 6-3, the total scores for all the visual and behavioural questions were calculated separately, generating two new variables for the subsequent analysis: the sum of the scores for the four visual questions (Items 13, 14, 15 and 18, noted as SumV) and the sum of the scores for the four behavioural questions (Items 11, 12, 16 and 17, noted as SumB), reflecting the extent of knowledge recall after reading for each participant. It is thus possible to check how photographs can affect participants' performance on knowledge recall.

The manipulated signage and photographs used in this section were about a local bird (i.e. the Common Kingfisher). In order to avoid potential bias from personal interests when testing the effectiveness of science communication, participants' interests in birds were examined and grouped. Participants were divided into three groups according to their interests in birds when completing the questionnaire: specialised bird watchers or bird enthusiasts (SB), people with a general interest in birds (GB) and those are not interested in birds (NB). The same interest group was also applied in Chapters 3, 4 and 5.

The targeted participants of this survey were the tourists (over eighteen years old) within the XNWP. During the survey, I was standing next to the manipulated sign (one of the three signs) and asking tourists to read the sign then fill out the anonymous questionnaire. The questionnaire was generated through an online website: wj.qq.com. Participants were able to scan a QR code provided by myself (printed on a card), which contained the link of the questionnaire (for details of the use of QR code in China see Section 2.6). Then they could complete the online questionnaire using their own smartphones. The questionnaire survey was approved by the University of Otago Human Ethics Committee (ID: 17/061). All the participants had read the information sheet (Appendix I) and agreed to participate before completing the questionnaire.

6.2.3. Statistical analysis and interpretations

A series of descriptive and quantitative methods were applied to analyse the data. For the data from observation, a Chi-square test was adopted to compare the frequencies of stops

(reading) and scans among the three signs (Pallant 2013), with post-hoc pairwise comparisons based on z-test being used (Sharpe 2015). For the questionnaire, the demographic characteristics of participants were described first, then the participants' choices for all the ten items reflecting the reading experience and post-reading response were reported. As this section involved the 5-point Likert scale, I used the Kruskal-Wallis test, which is a non-parametric test for non-normally distributed data with more than two groups, to examine the potential difference of participants' views among the three experimental conditions (signs). If the Kruskal-Wallis test reported a significant difference was existing, I would then perform pairwise comparisons with Dunn's tests (Pallant 2013; Statistics 2015). Once the item analysis above was completed, I then grouped the correlated items by factor analysis to check whether participants' perception of the photograph is related to one or more aspects of the effectiveness of science communication. The Principal Component Analysis (PCA) was the approach to extract factors, with only eigenvalues larger than 1.0 being outputted (Lambert et al. 1990). For the last section (i.e. the knowledge test) of the questionnaire, the variable SumV (sum of the scores for all the visual questions) and SumB (the sum of the scores for all the behavioural questions) for each participant were used to describe the participants' recall of knowledge based on the visual and behavioural facts presented in the signage. Kruskal-Wallis tests were also applied here to explore the potential difference of the test scores (SumV and SumB, respectively) among the manipulations.

6.3. Results

6.3.1. To read, or not to read? Observation on the attractiveness of the manipulated interpretive signs

A total of 2,705 tourists had passed by the manipulated signs during the period of observation. Frequencies of stops were transformed into proportions of the number of stopped visitors to the total number of visitors passing by. The comparisons of proportions between the three manipulations were illustrated in Fig. 6.2. The Chi-square test gave that visitors' intention to read was significantly affected by the manipulation of images (Pearson Chi-square = 56.36,

$p < 0.001$ for the proportions of the frequency of reading to the total passing). Specifically, the sign with a high-quality photograph received the highest proportions of stops (16.4%) and scans (8.1%), while the sign without a photograph (i.e. the control group) had a much lower attractiveness (8.7%), the pairwise comparison also suggested a significant difference between the above two groups (Pearson Chi-square = 25.04, $p < 0.001$). Lastly, the sign with a poor-quality photograph had the lowest proportion of stops amongst the three groups, accounting for 5.9% of all the tourists who passed by that sign. The pairwise comparison also gave a significant difference between the poor-quality group and the control group (Pearson Chi-square = 5.06, $p = 0.025$). On the other hand, it seems that the use and the visual quality of photographs did not affect visitor's willingness to scan the QR code on the signage (Pearson Chi-square = 4.71, $p = 0.095$ for the proportions of the frequency of scanning to the total reading), even though Fig. 6.2 suggests the visitors with the signage with a high-quality photograph had a higher intention to scan (8.1%) than the visitors with the other two signs did (2.0% for the signage with a poor-quality photograph and 2.4% for the control group).

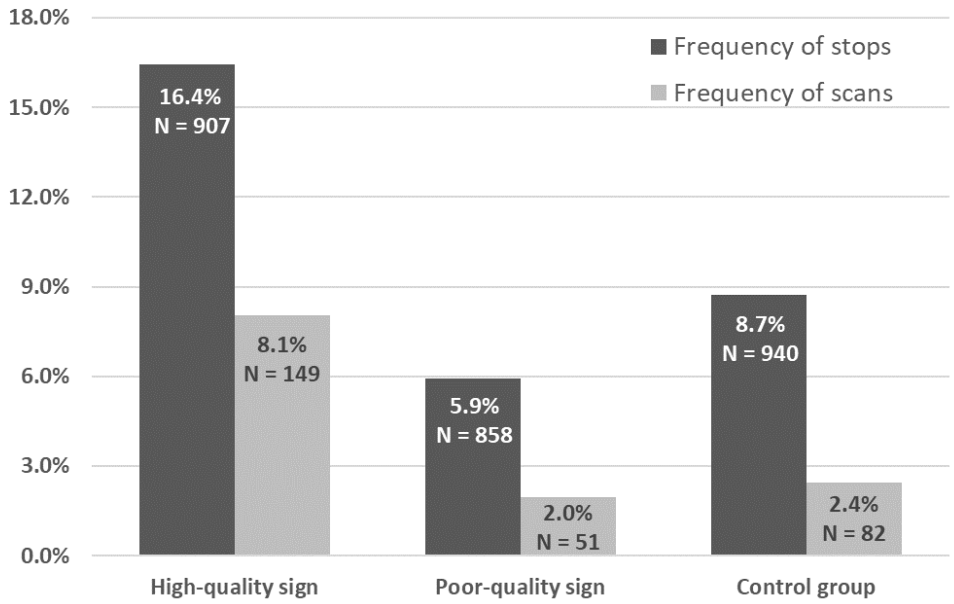


Fig. 6.2 Comparison of the frequency of stops among the three groups of signs across the three experimental groups. Group explanation: High-quality group: the sign with a high aesthetic value photograph); Poor-quality group: the sign with a poor aesthetic value photograph); Control group: the sign without any photograph.

6.3.2. The characteristics of the participants in the questionnaire survey

A total of 1,258 visitors within the park participated in the questionnaire survey. However, forty-two of them had not completed the questionnaire, with one or more items being left blank, comprising 3.3% of the total sample. These incomplete questionnaires were dropped from the sample population as these respondents were assumed to be a withdraw of participating in the survey according to the ethics approval. While the participants who chose the alternative "I would rather not say" or "I do not know" were included in the subsequent analysis. Thus, the usable sample population for the questionnaire survey was 1,216, with approximately a balanced sample size across the three experimental conditions. Demographic information was collected in the first section of the questionnaire and was summarised in Fig. 6.3.

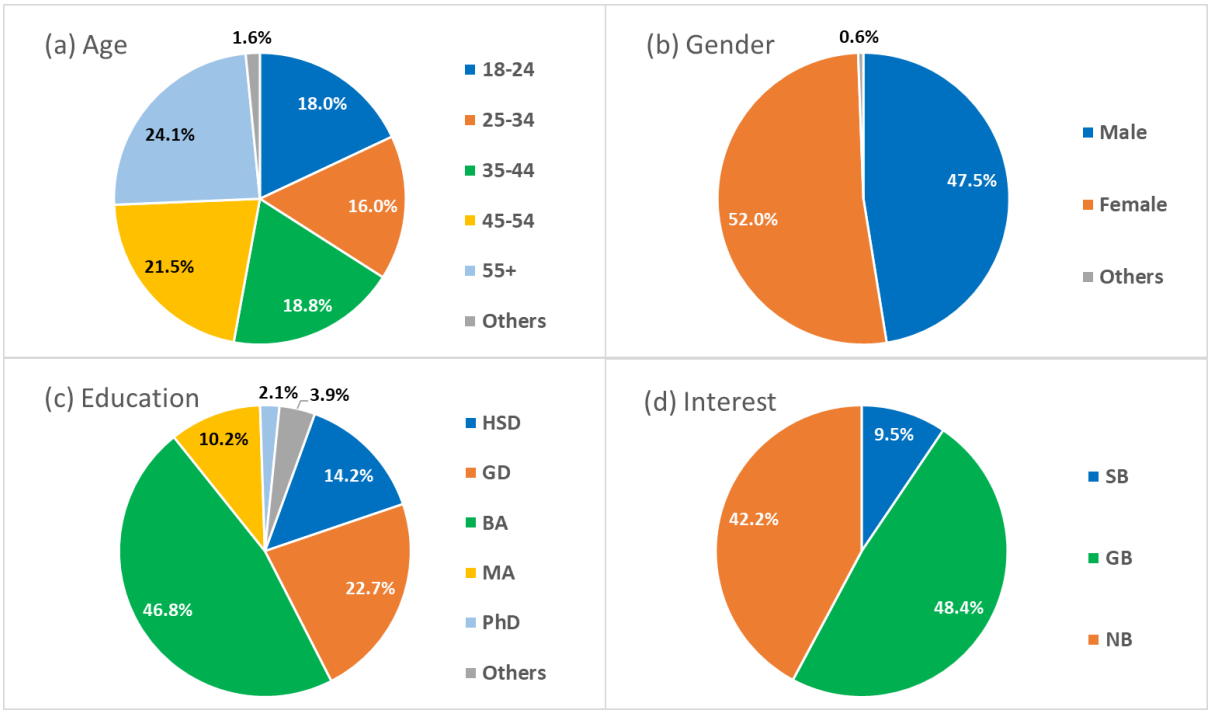


Fig. 6.3 Descriptive demographic information of respondents, n = 456. For the chart of education levels, HSD means a high school diploma or lower level, GD means a graduate diploma, BA means a bachelor's degree, MA means a master's degree or postgraduate diploma, and PHD means a Doctor of Philosophy. In the chart of interest groups, SB represents the participants with a specialised interest in birds (i.e. bird enthusiasts), GB represents the participants with a general interest in birds but do not have much experience and knowledge of watching and identifying birds, while NB represents those who are not interested in birds.

The socio-demographic information presented that the age group was generally balanced. However, younger people (age between eighteen and thirty-four) comprised 34.0% of the total participants, which is higher than the data of the same age group for Hangzhou city (22.3%) (Bureau Hangzhou Statistical 2018). Also, 85.8% of the participants had completed tertiary education, which is not reflective of the national data in China and the city data for Hangzhou (National Bureau of Statistics of China 2017; Bureau Hangzhou Statistical 2018). The relatively young and well-educated sample population is probably because the Zhejiang University, as one of the most well-known universities in China, is located in this area and is just about one kilometre from the XNWP (Zhejiang University 2017). This park is, therefore, likely to be an appropriate entertainment attraction for students and university staff (supported by a few comments from university students during the field survey). For genders, the proportion of female respondents was slightly larger than that of males, reflecting a similar sex ratio to the data of Hangzhou city (Bureau Hangzhou Statistical 2018). Lastly, participants' interests in birds gave that only 9.5% of them were knowledgeable bird enthusiasts, while most participants did not have specific knowledge about birds, though 48.4% of them were generally interested in birds. However, the proportions of different interests in birds could only report the interests of participants in this survey and might not reflective of the tourists within the park. Nevertheless, it can be estimated that there are much more GB and NB than SB. It should also be noted that the demographic and interest patterns in this survey were generally similar to those in my previous survey on the role of photographs for the performance of the existing signage (Chapter 5), since both the two surveys had been conducted within the XNWP.

6.3.3. Reading experience with the manipulated signage: the item analysis

The ten items in the second section of the questionnaire evaluated visitors' experiences of reading the manipulated signs. Descriptive results were demonstrated as follows. Responses from participants were illustrated by stacked bar graphs. Kruskal-Wallis tests were used to check the potential influence of the three manipulated signs on each item.

Item 1. I enjoy reading this sign

This item tested the enjoyment of reading. Results suggest that the visual quality of photograph significantly influenced whether reading the signage was an enjoyable experience (Kruskal-Wallis test, $p < 0.001$). Specifically, the sign with a high-quality photo was outstanding in the three manipulated signs, received much more positive responses than the other two groups did (Dunn's pairwise comparison, $p < 0.001$ between the high-quality and the poor-quality group, also between the high-quality and the control group). There was no significant difference between the signage with a poor-quality photo and the control group (Dunn's pairwise comparison, $p = 0.930$). Descriptive comparisons see Fig. 6.4.

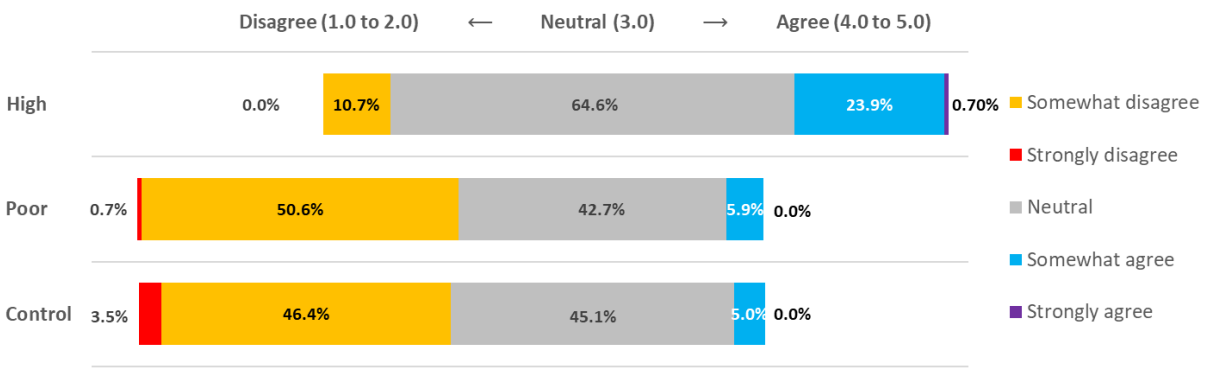


Fig. 6.4 Score frequency distribution (in percentages) of Item 1, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores. *High* means the sign with a high-quality photograph. *Poor* represents the sign with a poor-quality photograph, while *Control* means the control group (the sign without a photograph).

Item 2. The interpretive text information on this sign is attractive.

Item 2 tested the general attractiveness of the interpretive text information on the signage. Even though all the three signs had the same textual information, participants still had different perceptions of the text attractiveness for the three signs (Kruskal-Wallis test, $p < 0.001$), see Fig. 6.5. The signage with a poor-quality photograph received the most negative response compared with the other two signs (Dunn's pairwise comparison, $p < 0.001$ between the poor-quality and the high-quality group, also between the poor-quality and the

control group). However, the high-quality photograph did not show an outstanding effect here: The difference between the results in the high-quality and the control group was not significant (Dunn's pairwise comparison, $p = 0.103$).

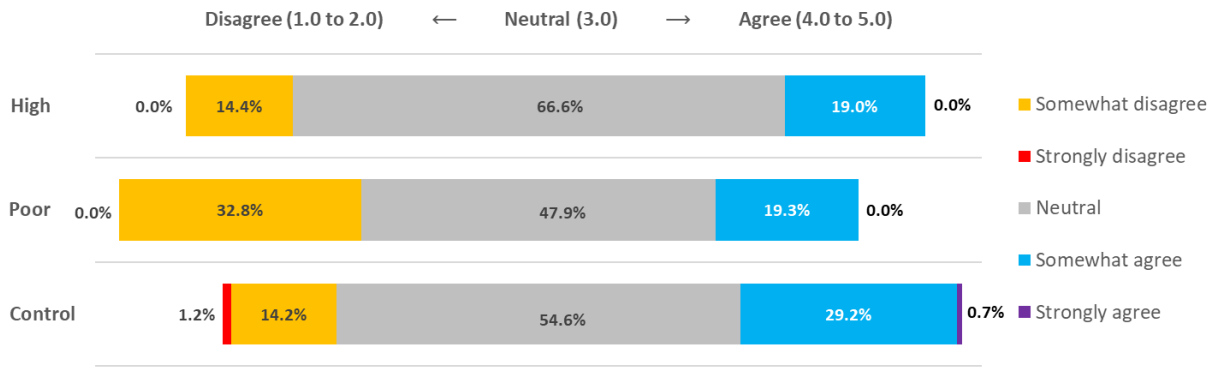


Fig. 6.5 Score frequency distribution (in percentages) of Item 2, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 3. The photograph used on the sign is appealing.

This item directly tested the attitude of participants towards the appeal of the photograph on the signage (i.e. perceived attractiveness of the photograph). As shown in Fig. 6.6, participants' perception of the attractiveness of the image was in line with the manipulation, i.e. the quality of photographs (Kruskal-Wallis test, $p < 0.001$). The high-quality group got a more positive evaluation than the other two groups did (Dunn's pairwise comparison, $p < 0.001$ between the high-quality and the poor-quality group, also between the high-quality and the control group): 73.2% of the participants who had read the signage with a high-quality photograph gave positive responses. By contrast, some 90% of the participants in the poor-quality group left negative responses. Interestingly, participants claimed that the attractiveness of the image on the control sign (the LOGO of the XNWP) was as low as the poor-quality photograph used in this survey (Dunn's pairwise comparison, $p = 0.844$ between the control and the poor-quality sign).

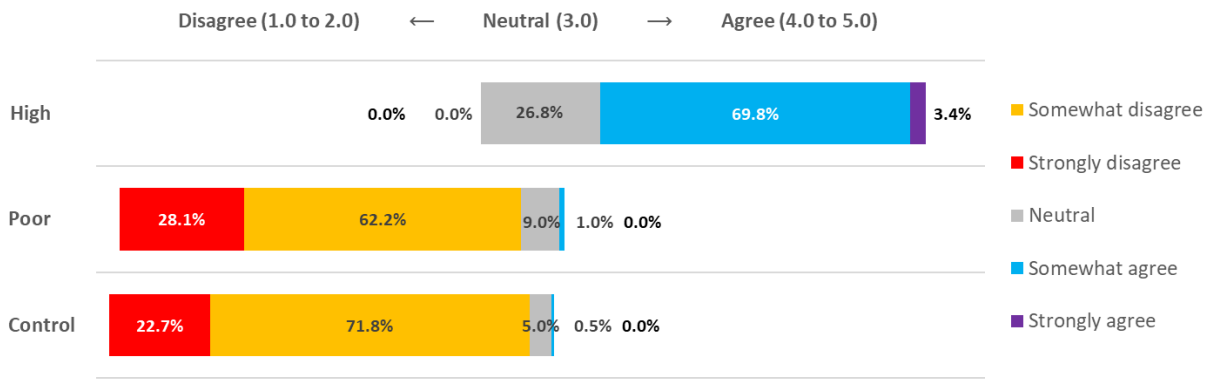


Fig. 6.6 Score frequency distribution (in percentages) of Item 3, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 4. I feel better informed by reading this sign.

Item 4 focused on whether participants felt they had gained knowledge about this topic after reading. As shown in Fig. 6.7, the majority of participants under all the three experimental conditions had positive responses. The influence of photographs was also detected (Kruskal-Wallis test, $p < 0.001$): Generally, people in the high-quality group gave the most positive responses, followed by those in the control group, while the poor-quality group had the smallest proportion of positive attitudes (agreed or strongly agreed) compared with the other two groups (Dunn's pairwise comparison, $p < 0.001$ for all the three pairs).

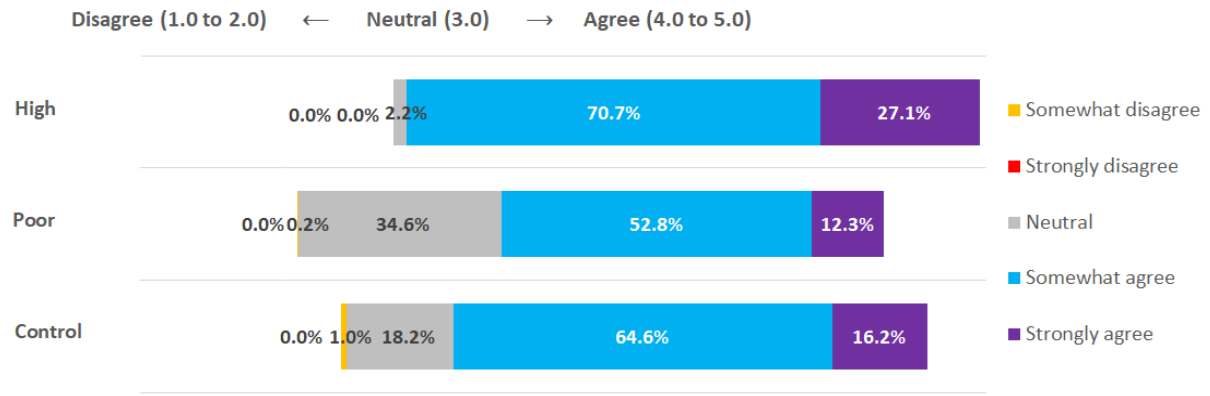


Fig. 6.7 Score frequency distribution (in percentages) of Item 4, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 5. The material increases my interests in the topic (i.e. birds).

Whether participants increased their interest in birds after reading the signage was tested here as an important aspect of the effectiveness of communication (Ham & Weiler 2006). Most participants (over 90% for each group) across all the experimental conditions did not think their interests in birds were enhanced by just reading interpretive signage. However, the quality of photographs seemed to still play a role here (Kruskal-Wallis test, $p < 0.001$): fewer participants in the high-quality group disagreed with the statement of this item than those in the poor-quality and the control group (Dunn's pairwise comparison, $p < 0.001$ between the high-quality and the control group, also between the high-quality and the poor-quality group), see Fig. 6.8. No significant difference was found between the poor-quality group and the control group (Dunn's pairwise comparison, $p = 0.251$).

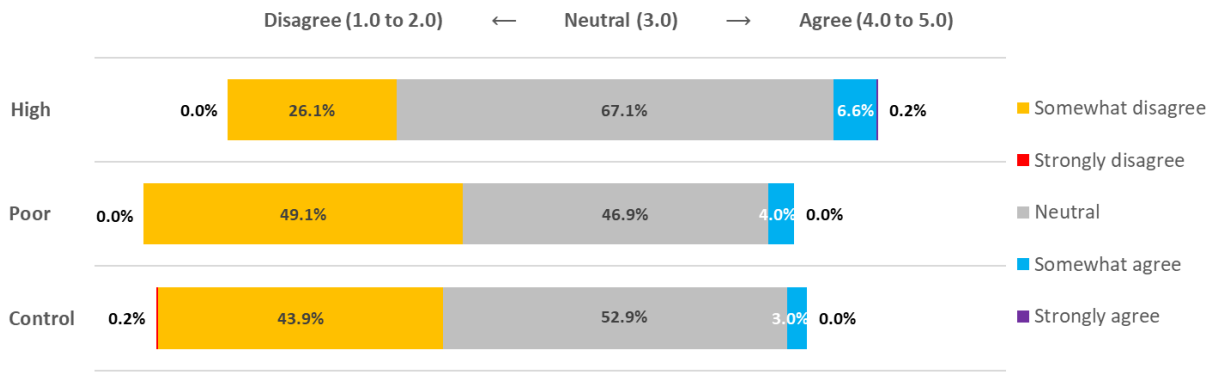


Fig. 6.8 Score frequency distribution (in percentages) of Item 5, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 6. I will share the scientific stories/facts I learned from this sign with friends/family.

Here, most of the participants did not think they would share the information with others, with only less than 10% of the total respondents agreed with the statement, see Fig. 6.9. The manipulation on the photographs was a significant influencer of willingness to share the information on the signage (Kruskal-Wallis test, $p < 0.001$). Interestingly, the participants in the control group had a more negative attitude towards sharing than those in the other two

groups did (Dunn's pairwise comparison, $p < 0.001$ between the control group and the high-quality group, and $p = 0.007$ between the control group and the poor-quality group), while the difference between the high-quality and the poor-quality group was not significant (Dunn's pairwise comparison, $p = 0.074$).

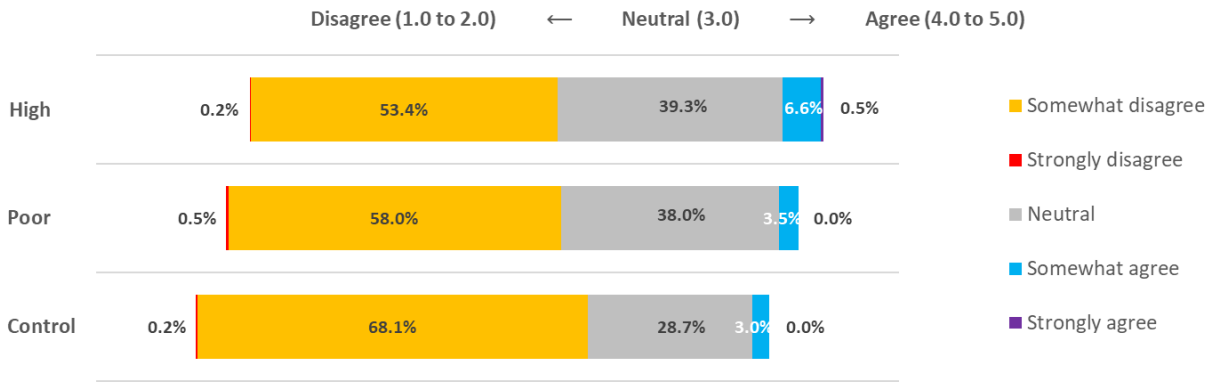


Fig. 6.9 Score frequency distribution (in percentages) of Item 6, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 7 I have known most of the scientific matters interpreted by the sign already before reading.

This item tested prior knowledge about the topic interpreted in the signage. As shown in Fig. 6.10, the majority of participants did not have much knowledge of Common Kingfisher. Also, the responses of participants to this item did not show any significant difference across the three manipulated signs (Kruskal-Wallis test, $p = 0.497$).

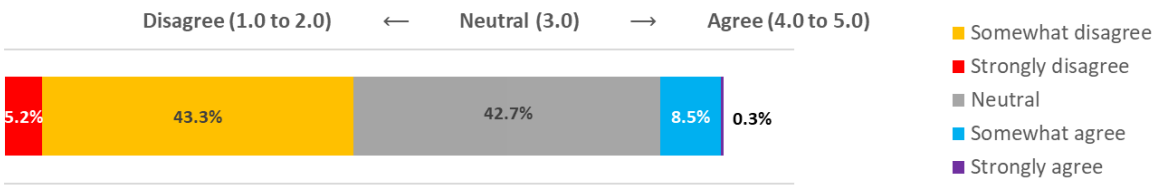


Fig. 6.10 Score frequency distribution (in percentages) of Item 7, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item.

Item 8 I am clear about the meanings of the ornithological concepts referred to in the text on this sign.

This item looked at participants' understanding of the ornithological terms and concepts referred by the interpretive information. The comparison across the three groups did not reveal any significant difference (Kruskal-Wallis test, $p = 0.208$). However, participants' prior knowledge may play a role here, as the score frequency distribution was similar to that for testing the prior knowledge (Item 7): only no more than one-fifth of the participants stated that they did not have any difficulties with the relevant terms and concepts (see Fig. 6.11).

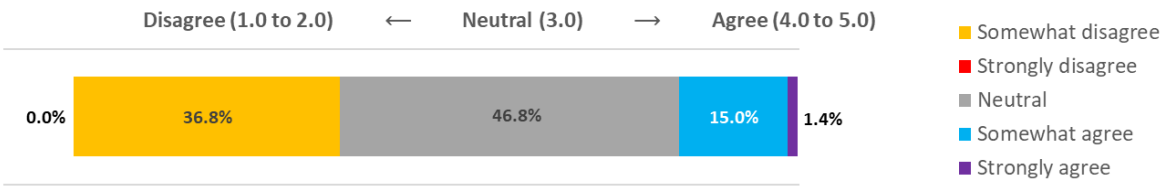


Fig. 6.11 Score frequency distribution (in percentages) of Item 8, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item.

Item 9. The image on this sign can help me understand the text information better.

Item 9 tested the potential relationship between the appearance of images and understanding of reading. As illustrated in Fig. 6.12, the influence of manipulation was significant (Kruskal-Wallis test, $p < 0.001$). Compared with the poor-quality photo and the control group, a high-quality photograph indeed helped to understand the scientific information better (Dunn's pairwise comparison, $p < 0.001$ between the high-quality and the control group, also between the high-quality and the poor-quality group). On the other hand, participants did not think the poor-quality photograph and the LOGO of the XNWP (i.e. the control group) had any positive influence on the understanding of reading. However, even though the Likert scale scores of both the two groups above were low, the score of the poor-quality group was still higher than that of the control group (Dunn's pairwise comparison, $p = 0.007$).

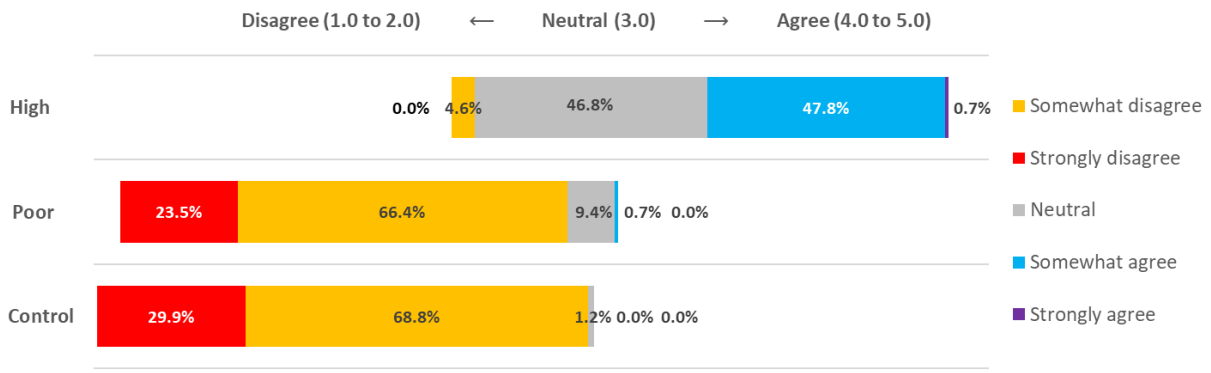


Fig. 6.12 Score frequency distribution (in percentages) of Item 9, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

Item 10. If the researcher did not ask me to read the interpretive sign and complete this questionnaire, I would still like to stop to read it.

This item is a supportive item to the observation section, testing the general attractiveness of the signage to the tourists passing by it. Results show that the majority of participants might not stop to read the sign (see Fig. 6.13). People's willingness to read was varied by the qualities of photographs (Kruskal-Wallis test, $p < 0.001$). The signage with a high-quality photograph received the strongest willingness to read among the three groups (Dunn's pairwise comparison, $p < 0.001$ between the high-quality and the control group, also between the high-quality and the poor-quality group), while there was no significant difference between the poor-quality and the control group (Dunn's pairwise comparison, $p = 0.946$).

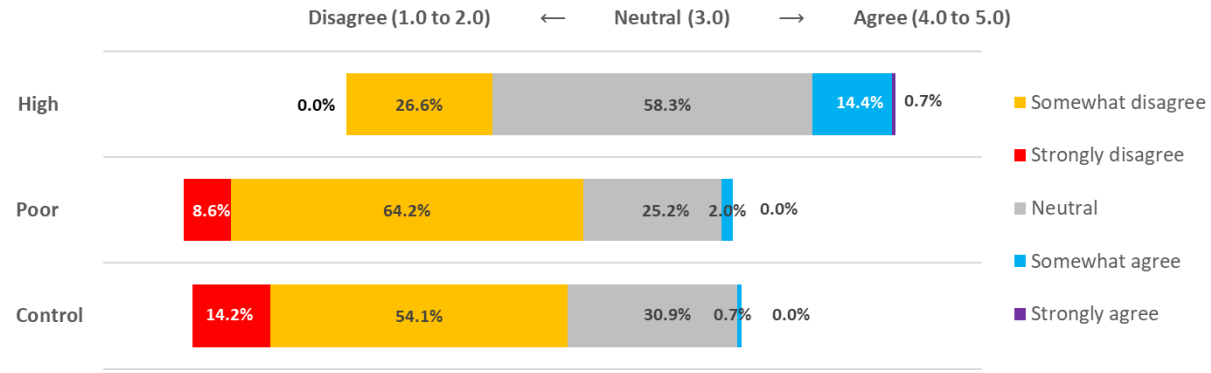


Fig. 6.13 Score frequency distribution (in percentages) of Item 10, n = 1,216. Colours (i.e. scores) in the chart show the participants' attitudes towards the statement of this item. Results show a significant influence of the manipulated visual elements (photograph) on the scores.

6.3.4. Linking qualities of photographs with reading experience

The factor analysis successfully extracted the different aspects of the effectiveness and clarified the aspect in relation to photographs. Factors were extracted via a principal components analysis (PCA) and then experienced a varimax rotation so that the results could be better interpreted (Pallant 2013). A total of three factors were extracted, explaining 64.8% of the total variance (Table 6-4).

Table 6-4 Three dimensions of evaluating the effectiveness of the manipulated signs for science communication based on the extracted factors. Items were questions (including the ID and a brief description of each item) in the questionnaire. All the loadings were significant.

Factor	Description	Item	Brief description of the item	Loading
I	Image-related effectiveness 26.3% of variance	Item 1	Reading engagement	0.586
		Item 3	Perceived attractiveness of the image on the signage	0.922
		Item 9	Influence of the image on the understanding of reading	0.885
		Item 10	Willingness to read the signage (self-evaluated)	0.693
II	Text-related effectiveness 21.9% of variance	Item 2	Attractiveness of the textual information on the signage	0.786
		Item 4	Knowledge gained (self-evaluated)	0.688
		Item 5	Interest enhanced	0.718
		Item 6	Intention to share	0.625
III	Comprehension based on prior knowledge 16.6% of variance	Item 7	Prior knowledge	0.868
		Item 8	Concepts comprehension	0.875

As shown in Table 6-4, Factor 1 (image-related effectiveness) was the most important factor when evaluating the performance of the interpretive signage in this experiment, explaining 26.3% of the total variance. This factor was named in relation to image because the item that tested the attractiveness of the image on the signage (Item 3) was significantly loaded here, with a conspicuous loading of 0.922, suggesting this factor was closely related to the quality of images (measured as attractiveness by participants). Furthermore, the influence of the image on understanding (Item 9) was also included in Factor 1. Specifically, a high-quality photograph means a high perceived appeal here (Item 3). Such a photograph promoted the understanding of reading. In addition, engagement (Item 1) and willingness to read the signage (Item 10) were also loaded on this factor. Both the two items above positively

correlated to the perceived attractiveness of photographs significantly (Pearson's $r = 0.47$, $p < 0.001$ between Item 1 and Item 3; $r = 0.62$, $p < 0.001$ between Item 10 and Item 3, based on the correlation matrix of the factor analysis). Three functions of images were, therefore, clarified here: motivating individuals to read (i.e. attracting attention), improving reading engagement and understanding.

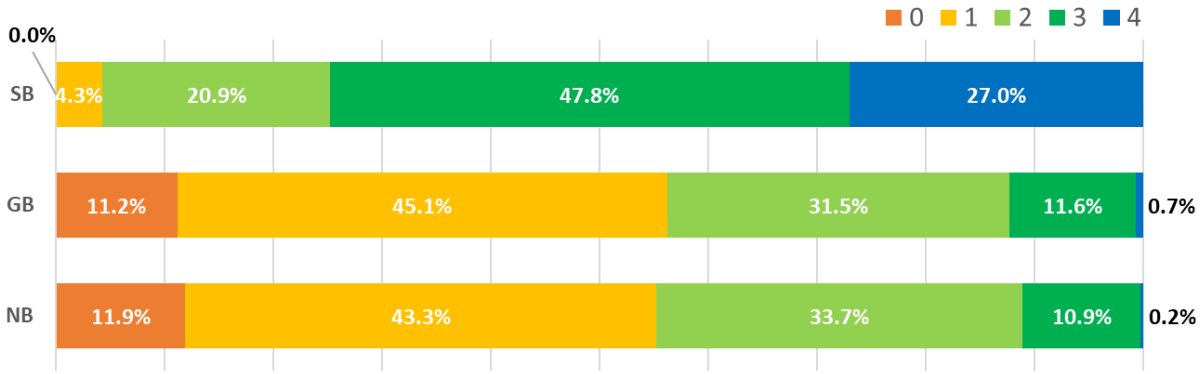
Factor 2 showed how the attractiveness of the text (Item 2), instead of images, was correlated to the three aspects (Item 4, 5 and 6) of the effectiveness of communication. It was, therefore, named as text-related effectiveness. It explained 21.9% of the total variance, which was just slightly less than that of the first factor. This factor was described by participants' general perceptions of the text information (Item 2), knowledge gained (Item 4), interest enhanced (Item 5) as well as post-reading supports (willingness to share, Item 6), suggesting attractive textual content on the interpretive signage could better inform participants, increase their interests and intention to share the knowledge.

Factor 3 was characterised by participants' prior knowledge (Item 7) and comprehension of the ornithological concepts appeared on the signage (Item 8). This factor suggested a close relationship between participants' prior knowledge of the bird (the Common kingfisher here) and their comprehension of the ornithological concepts interpreted in the signage. It is thus defined as comprehension based on prior knowledge. This dimension seemed not to be affected by the quality of images quite much: all the correlation coefficients between any of the items above (Items 7 and 8) and the attractiveness of image (Item 3) were below 0.3 (Pearson's $r = 0.04$, $p = 0.099$ between Item 7 and Item 3; $r = 0.03$, $p = 0.137$ between Item 8 and Item 3 according to the correlation matrix of the factor analysis).

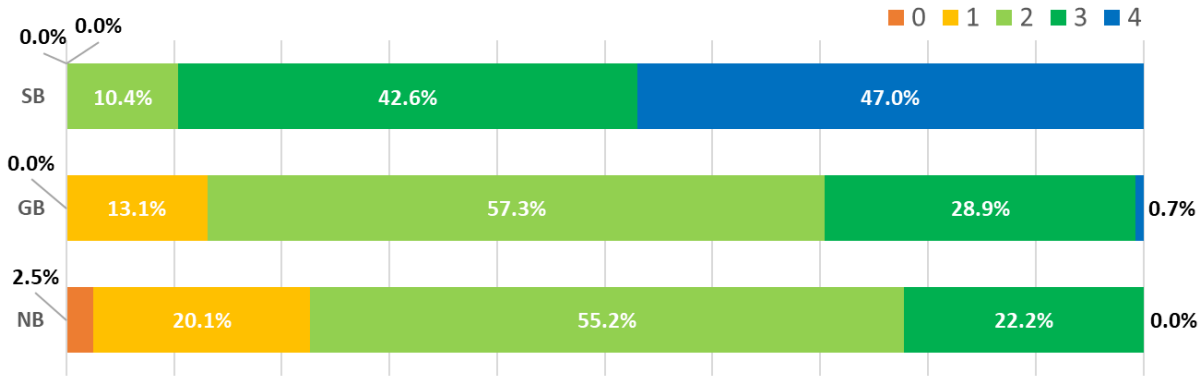
6.3.5. The knowledge test: recall of knowledge acquired from the signage

The purpose of this knowledge test was to examine the recall of the scientific information interpreted by the signage. However, participants might answer the test question based on their prior knowledge about the Common Kingfisher rather than the knowledge acquired through the signage. This is a potential issue, especially for those SB who were grouped as knowledgeable bird enthusiasts. They are likely to know quite a lot about the Common Kingfisher, including the questions asked in this test, even though these questions were about the detailed visual or behavioural traits of the bird. In this circumstance, the result of this knowledge test for these participants cannot reflect the exact performance of knowledge recall.

Results of the test suggested that the above implication indeed existed. As shown in Fig. 6.14, SB got much higher scores in both two parts of the knowledge test (visual and behavioural traits) compared with GB and NB. As defined in the methodology section, SumV (Fig. 6.14a) and SumB (Fig. 6.14b) represented the sum of scores (i.e. the number of correct answers) for the four visual trait questions and the four behavioural trait questions respectively, which ranged between zero to four as there were four questions for each section. For visual trait questions (SumV), the majority of SB (74.8%) got three or four correct answers, whereas only less than 15% of GB and NB had such performance. Similarly, 89.6% of SB had three or more correct answers for questions about behavioural traits (SumB), which was a much better performance than that of GB and NB (29.6% and 22.2%, respectively). Furthermore, during the period of the test, a few bird watchers (in the group of SB) also claimed they had already known these traits, which proved that the interference from the prior knowledge of SB on the results of the test was tangible.



(a)



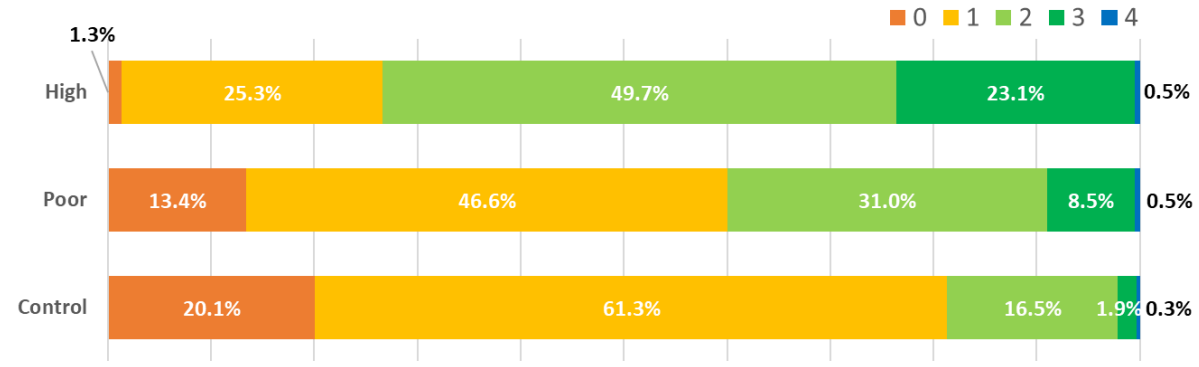
(b)

Fig. 6.14 Distributions of scores of the knowledge test (in percentages) by interests, n = 1,216. The test included two sections: questions about visual traits of the bird (a) and about behavioural traits (b). Each section had four questions. Therefore, the total score ranged between zero to four for each section, which was noted as SumV for the visual section and SumB for the behavioural section in the subsequent analysis. SB, GB and NB represent different interest groups: specialised bird enthusiasts, those with a general interest in birds and are not interested in birds, respectively.

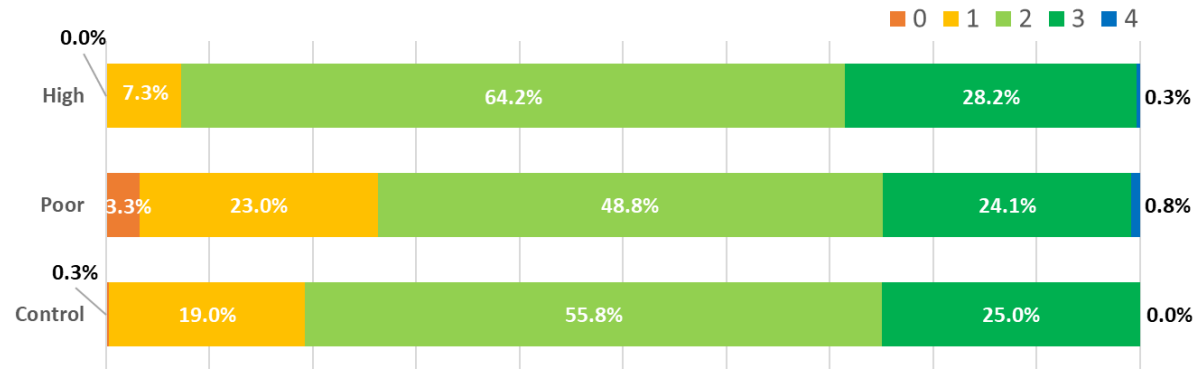
In order to avoid the interference of participants' prior knowledge, the knowledge test scores by all the SB were dropped in this section. Only the data of GB and NB (n = 1,101) entered the subsequent analysis on the role of photographs in knowledge recall. Apart from the removed SB, the score of other participants (GB and NB) were comparable. They generally got only one correct answer (45.1% for GB and 43.3% for NB) in the visual trait section and two correct answers (57.3% for GB and 55.2% for NB) in the behavioural trait section (Fig. 6.14).

Based on the answers of the 1,101 participants in this stage of research, the Kruskal-Wallis tests for SumV and SumB with the manipulation (signage with different images) as groups

reported a significant influence from the use and the visual quality of photographs (Kruskal-Wallis, $p < 0.001$ for the tests of both SumV and SumB). As illustrated in Fig. 6.15a, participants got amazingly high scores for visual trait questions (SumV) with the signage with a high-quality photograph: 23.1% of them got at least three correct answers, which was much larger than the proportion for the group with a poor-quality photograph (9.0%). The control group without a photograph got the poorest performance in SumV: the majority of them (61.3%) only got one correct answer, and only 2.2% of them had three or more correct answers. The Dunn's pairwise comparisons got significant results for all the three pairs across the high-quality, poor-quality and control group (Dunn's, $p < 0.001$ for all the pairs).



(a)



(b)

Fig. 6.15 Distributions of scores of the knowledge test (in percentages), n = 1,101. The scores of visual trait questions (a) and behavioural questions (b) were illustrated, respectively. *High* means the sign with a high-quality photograph. *Poor* represents the sign with a poor-quality photograph, while *Control* means the control group (the sign without a photograph).

As to the results of the four questions about behavioural traits (SumB), the participants in the group with a high-quality photograph still performed the best amongst the three groups (Dunn's pairwise comparison, $p < 0.001$ between the high-quality group and the low-quality group, $p = 0.002$ between the high-quality group and the control group). However, even though the influence of the manipulation was significant, the benefit of a high-quality photograph to participants here was not as noticeable as the benefit of the same group for the visual trait questions. For SumB, the proportions of participants with three or four correct answers were 28.5% for the high-quality group, 24.9% for the poor-quality group and 25.0% for the control group – all of them ranged between 20% and 30% (see Fig. 6.15b). It should also be noted that no significant difference was found between the knowledge recall for the poor-quality group and the control group (Dunn's pairwise comparison, $p = 0.15$), suggesting the influence of the visual characteristics of photographs was more significant than the influence of the presence/absence of photographs here.

6.4. Discussion

6.4.1. Intention to read an interpretive sign

This study examined the role of photographs for enhancing natural science communication from the affective and cognitive aspect. The affective effectiveness included any emotion responses towards the interpretive signage (Ham & Weiler 2006; Ismail 2008). Amongst such emotional responses, the public's willingness to read (i.e. attention) is one of the vital aspects of evaluating the effectiveness of signage for communication. This factor is important because if individuals decide not to read an interpretive sign, it is impossible to have any reading experience or acquire knowledge through this signage. Therefore, being attractive is the first and a major task of the interpretive signage. Results based on the observation suggest that the visual quality of the photographs had a significant influence on tourists' intention to read the signage: the more appealing the photograph, the more attractive the signage was to the tourists. In other words, the attractiveness of the signs was affected

by the visual quality of images used in this experiment, because the only manipulated element on the signage was the image.

The relationship between appealing images and the audience's emotional response (e.g. attention, enjoyment) has also been explored by several scholars. For example, Redi and Povoa (2013) introduced observers' visual attention deployment in judging the aesthetic appeal of images. A Korean study focusing on human brand images stated that the appeal of the images significantly positive influence on a customer's visual attention and willingness to purchase the relevant product (Seo et al. 2012). Visual attention and willingness to purchase the product were the primarily focused responses studied by Seo et al. (2012). While for the interpretive signage in this study, I looked at similar types of responses: to be attracted (draw visual attention) and to stop to read the signage (take action). Based on this attention-to-response procedure, both studies confirmed the importance of high-quality images for people's visual attention and the subsequent responses.

Interestingly, the attractiveness of the signage with a poor-quality photograph was even lower than that of the control group, while there was no significant difference between the visitor's perceived appeal of the images in the two groups (see results of Item 3, the comparison between the signage with the poor photograph and the LOGO of the XNWP). In order to explore how the performances of the appealing and the poor photographs differed, the poor photo of Common Kingfisher used here was blurred (the bird was still identifiable) with a very low aesthetic score via the Acquine. Such a poor wildlife photograph is apparently not likely to be used by most national parks under real circumstances. However, this experiment still revealed the use of photographs does not always enhance science communication. Using a poor photo may even decrease the overall attractiveness of the signage compared with not using any photographs.

Why do visitors decide to read the interpretive signage within a national park? According to the observational results with the three manipulated signs, the visual quality of the photograph on the signage was the only significant element that affected tourists' willingness

to read. As described in Chapter 5, most GB and NB recognised the interpretive signage with an appealing photograph could attract them to read. However, from the perspective of tourists, the attractiveness of the signage or the photograph was probably just one of the many factors that potentially motivate them to stop to read (Scherer et al. 2001; Ballantyne et al. 2006). Tourists' general attitude towards the interpretive signage and their interests in the topic (e.g. bird) interpreted on the signage may also play a role: results in Chapter 5 suggested that 46.9% of the participants who had a general interest in birds would look for and read the interpretive signage about birds on purpose when visiting a national park (Section 5.3.2, Item 1).

6.4.2. The contribution of a high-quality photograph: affective and cognitive outcomes

The extracted factors through the factor analysis reflected three distinct dimensions to evaluate the effectiveness of the signage: image-related effectiveness, textual content-related effectiveness and the influence from prior knowledge. The linkage between the visual appeal of the image and the effectiveness of interpretation was revealed by the first factor, which explained the largest proportion of the total variance in the factor analysis.

Unsurprisingly, the perceived attractiveness of the photograph on the signage (Item 3) was determined by its visual quality (i.e. the aesthetic score by Acquine). Participants' experience of reading was more enjoyable and easier with the signage with a high-quality photograph (for details see Item 1 and Item 9). Similarly, the positive influence of a high-quality photograph on engagement and understanding was also identified by the survey on the existing signage within the XNWP (Chapter 5). Such positive influences of images on the enjoyment of reading have been identified by researchers for decades (Levie & Lentz 1982; Houts et al. 2006). However, they hardly focused on how such contribution of images was affected by their visual appeal. According to the results of this chapter, only those appealing photographs (defined by the high visual quality here) could significantly enhance participants' enjoyment. This finding revealed the importance of using high-quality

photographs for communication, because enjoyment, as a positive emotional response, has been considered as an important aspect of the effectiveness (i.e. affective outcomes) of the interpretation of natural stories within national parks (Ham & Weiler 2006) and the communication of more topics on science (Burns et al. 2003).

The relationship between the visual quality of photographs and understanding of reading can be explained by the role of visualisation in science communication: one of the major purposes of using interpretive signage within national parks is to increase tourists' understanding of science stories about nature (e.g. biodiversity, environment, landscape, conservation, etc.) (Department of Conservation 2005; Tilden 2009). As reported in the results, most tourists are not knowledgeable enough in the particular topics interpreted by the signage (e.g. birds). Therefore, the issue of understanding arises. Similarly, whether the general public has difficulty understanding the scientific material has also been a vital aspect of evaluating the effectiveness of science communication (Evans & Durant 1995; Burns et al. 2003). To enhance the public's understanding of science through different platforms (e.g. interpretive signage), visualisation has been a recommended approach (Trumbo 1999; Pauwels 2006; Estrada & Davis 2015). As a well-known type of images commonly used by both the general public and the scientific society, photography has become an appropriate way to visualise abstract and unfamiliar scientific information for the general public (Henkes 1975; Caivano 2008; Van Dijck 2008), and can therefore improve understanding of reading in the context of interpretive signage. As reviewed in Section 2.4.2, photography, as a form of the visual arts, can present natural subjects (e.g. birds) in an objective and appealing way, which may help tourists better understand the relevant interpretive content. The findings in this chapter confirmed such influences, but also emphasised the significant implication of the visual characteristics of photographs here: the contribution of photographs to science communication is significant only if such a photograph is of high visual quality.

Another important aspect is that even though the perceived attractiveness of the text on the signage was loaded on a different factor (Text-related Effectiveness, Factor 2) instead of Factor 1, it was still affected by the visual quality of the photograph to some extent,

especially when the quality of the photograph is poor. Specifically, participants in the poor-quality group had significantly more negative responses to the attractiveness of the textual information on the signage (see Item 2 of the questionnaire survey in Chapter 6), reflecting another important disadvantage of using poor-quality photos apart from the decrease of the intention to read.

6.4.3. The role of high-quality photographs in knowledge recall

As reviewed in Section 2.4.1, an effective science communication activity can be reflected by a number of aspects (Burns et al. 2003; Ham & Weiler 2006). Apart from the emotional responses such as attention and engagement, cognitive outcomes (e.g. knowledge gain and recall) and behavioural outcomes (e.g. behavioural changes) are the most important aspects amongst them (Ham & Weiler 2007), which have been particularly concerned by in the field of health, nature, biodiversity and conservation communication (Houts et al. 2006; Ismail 2008; Jordan et al. 2011). In the present study, the content of the manipulated signage was basically an introductory story about the Common Kingfisher. The focused aspect of the effectiveness of communication was, therefore, knowledge gain rather than behavioural changes in this study.

I designed the knowledge test in the last section of the questionnaire to test the recall of the content interpreted on the signage, including eight specific questions about visual traits and behavioural traits of the Common Kingfisher interpreted by the signage. Results report a significant influence of the visual quality of photographs on knowledge recall: participants performed much better in the test after reading the signage with a high-quality photograph than the signage with the poor-quality photograph and the control group. This trend was especially noticeable in the visual trait section (corresponding to SumV in the results).

The linkage between the high-quality photograph and knowledge recall may be explained from the perspective of emotional affinity, which was defined as “visitors report emotional responses to the experience or emotional connections with the animals they observed”

(Ballantyne et al. 2011). Positive emotions play an important role in knowledge gain as they can prompt curiosity (Berlyne 1960), and often related to the willingness to acquire more relevant knowledge (Renninger et al. 2014). As stated by Mihaly and Hermanson (2001), emotions are one of the most important motivations to learn and explore. For example, Ballantyne et al. (2011), based on their study on wildlife tourism in Australia, suggested if tourists were impressed by the wildlife encountered during the tour, such an emotional affinity would motivate them to learn and remember the interpretive information about the wildlife themselves, the relationship between human and wildlife, as well as actions that they could take for conservation issues.

How to promote positive emotions or emotional affinities through nature tours? Apparently, tourists are likely to be impressed and promote emotional affinities through the experience of wildlife encounters (Tubb 2003; Ballantyne et al. 2011). On the other hand, for most people who do not have specific knowledge how to find and identify the wildlife, interpretive signage (and other similar media) is probably one of the most important approaches to "encountering" nature (local biodiversity, landscape, *etc.*) in a scientific way. For nature exposure activities (e.g. wildlife encounter tours), the positive emotional responses to such experiences are related to an important factor: aesthetics of nature (e.g. wildlife). Medved and Oatley (2000), in the context of marine wildlife encounter tourism, stressed that tourists were likely to benefit from the aesthetic and emotional aspects, and these two aspects were related (see also Chapter 3 of this thesis). Specifically, aesthetics might prompt enjoyment as well as other positive impressions, including emotional affinity, such positive emotions then probably contribute to knowledge gain through interpretation (Tubb 2003; Hvenegaard 2017). As to the present study, the interpretive signage was manipulated by the visual appeal of the photographs on it: the sign with an appealing photograph (high visual quality) and the sign with a poor photograph (poor visual quality). Here the qualities of photographs were differed by visual aesthetics (Datta et al. 2006; Bhattacharya et al. 2010; Li et al. 2010b). Results show that participants enjoyed reading after they had read the signage with a high-quality photograph. Such positive emotion prompted by aesthetics might be an important reason why participants had the best performance in knowledge recall in the high-quality

group. Therefore, the affective aspects (i.e. emotional responses) and the cognitive aspects of the effectiveness of science communication are related to each other, and both aspects can be enhanced by the used of an appealing photograph on the signage.

6.5. Conclusion and implications

This is the first study examining the value of the use and the visual appeal of photographs in the context of interpreting natural attractions within national parks through interpretive signage. It can be concluded that the visual appeal of photographs indeed has a significant influence mainly on the affective and cognitive outcomes of science communication. Photographs are most effective for communication of natural stories through interpretive signage when they are of high visual quality.

Results show that there is a significant relationship between the visual quality of the photograph and tourists' affective responses (intention to read and reading engagement) to the interpretive signage. Especially, the present study emphasised that the interpretive signage with a high-quality photograph could attract visitors in national parks to read the signage. By contrast, if the quality of a photograph on the signage is extremely poor, it might make the signage even less attractive than that without a photograph. As to the cognitive effectiveness, a high-quality photograph can enhance participants' understanding of reading and their recall of knowledge. The results of the knowledge test suggest that a high-quality photograph could motivate participants to remember more detailed information interpreted in the signage, which was possibly driven by the emotional affinity promoted from the positive reading experience, especially the enjoyment with the experience of reading.

Chapter 7. Factors of WeChat Public Account Articles that Affect Communication of Natural Sciences

7.1. Introduction

Within natural areas such as national parks, nature interpretation is an important means to build the human-nature connection and increase visitors' understanding of natural sciences (Kuo 2002; Department of Conservation 2005; Ham & Weiler 2006). In Chapters 5 and 6, I found that using high-quality photographs is a useful tool to enhance the effectiveness of the onsite interpretive signage for communication. As reviewed in Section 2.3.3, apart from the onsite interpretive products, online interpretive platforms are also an important means to communicate natural science and attract individuals to visit national parks. For example, based on the popularity of smartphones and mobile social media in China (Cheng et al. 2015; Harwit 2017), the most popular social media application WeChat is a suggested novel method to interpret natural science stories (Wu et al. 2015; Tencent 2017; Xishuangbanna Tropical Botanical Garden (Chinese Academy of Sciences) 2018), see also Section 2.5.2.1 for an overview of WeChat. Based on the popularity of the QR code in China (as reviewed in Section 2.6), using the QR code which contains the link of an interpretive WeChat article or a certain WeChat mini programme has been a suggested method to enable the tourists to acquire further knowledge of nature (Liu et al. 2015).

As a social media application for smartphones, WeChat has been the most successful mobile application in China since 2011 (Harwit 2017). WeChat Public Account is a vital function of WeChat. Individuals or organisations are able to create their own public accounts; then they are able to generate articles and push them to their followers (detail descriptions of WeChat Public Accounts see Section 2.5.2). With its features of user-generated content and social network, WeChat Public Account has provided an opportunity for communicating about nature stories in a more effective way (Wu et al. 2015; Jin et al. 2017; Li 2017).

However, compared to the performance of WeChat articles in other popular fields (e.g. health, sports, sex), the popularity of interpretive articles about natural science is not as good as expected, due to: (i) the poor popularity and low frequency of pushing articles, (ii) the poor content diversity: most authors just re-write or translate scientific information instead of producing original stories, and (iii) the lack of visualisation and interaction (Zhou et al. 2016). Given this, using attractive images has been a suggested resolution to make the articles more engagement (Zhou et al. 2016), though there is no empirical evidence to support how those images enhance the experience of reading WeChat articles.

Encouragingly, with the traditional interpretive product: the interpretive signage, I found that high-quality photographs can successfully draw visitor's attention, increase understanding, engagement and recall of knowledge (Chapter 6). The contributions of photographs to draw attention and enhance the experience of reading through other popular online platforms were also investigated and confirmed by a number of studies (Thorlacius 2002; Badger 2004; Thorlacius 2007) (see Section 2.5.3 for a detailed review on the potential contribution of images to online materials). Considering the significant roles of images above, it is thus valuable to explore whether the photographs' visual appeal can influence the performance of WeChat articles.

The survey in this chapter is conducted in the context of WeChat articles about natural science stories (i.e. interpretive popular science articles) because WeChat articles are considered as a potentially effective interpretive product to communicate the stories about the natural attractions within most national parks (see Section 2.5.2). Specifically, there are a number of factors such as title, topic and writing style influencing the performance of a WeChat article (Wu et al. 2015; Zhou et al. 2016; Li 2017). I here explore whether an appealing photograph is one of these influencers. Compared with these factors, what is the potential value of high-quality photograph in enhancing the performance of articles? As reviewed above, the performance of a WeChat article is assessed through the willingness to read and the potential positive reactions after reading (i.e. thumb-up and share). The focus is on visual appeal because I confirmed appealing photographs could successfully grab

people's attention in my previous survey (Chapters 3 and Chapter 6). Additionally, different visual attributes of photographs had varied effects on the attractiveness of photographs (Chapter 4). Therefore, within the context of WeChat articles, the specific influence of photographs' visual attributes on their efficacy for science communication is also examined in this chapter.

7.2. Methodology

As WeChat is a mobile application, a twelve-item online questionnaire designed for mobile devices was used to test participants' views on the potential value of photographs in popular science WeChat articles about nature. The questionnaire (for the full questionnaire see Appendix M) included three parts: socio-demographic information (Items 1 to 3) were collected at first as supportive information. Next, participants' interest in nature was examined (Items 4 and 5). Lastly, participants' preferred length of an interpretive WeChat article about nature was also collected in the first section because this factor was suggested as an important factor that reflected WeChat users' different reading habits and preferences, which may help to describe the characteristics of participants (Fang & Zhang 2015; Tencent 2017).

Apart from the first section, the next section of the online questionnaire aimed to test the research question of this chapter. As referred to in the study aims, the photographic element is potentially just one of the many factors influencing the users' reading experience. Reading experience can be measured through the performance of a WeChat article based on the following three actions: willingness to read (pre-reading action), thumb-ups and shares (post-reading social reference actions) (Zhou et al. 2016). Descriptions of the concepts and actions above see Chapter 2. However, such reactions cannot directly distinguish whether their motivation is due to high-quality photographs or other visual, textual, expressive or social factors. Given this, in the next section of the questionnaire, participants were asked to choose which factor(s) motivates them to read, like (thumb-up) and share a WeChat article. For the willingness to read a WeChat article, the alternatives included the elements presented

when the users see the link of an article: the title, the cover image, and the name of the author/public account who has pushed/shared the article. It is important that the cover image, also known as a headline image, is a prominent image that accompanies the title of the article (for detailed descriptions see Section 2.5.2.1). Selecting or uploading a cover image is a required step for generating a WeChat article. However, when users share a WeChat article in their WeChat Moments, a smaller and cropped cover image will be shown next to the title instead of the full image (a description of WeChat Moments see Section 2.5.2.1). For the questions about post-reading social reference actions (i.e. thumb-up or share, Items 8 to 10), the alternatives included an attractive title, in-depth/useful content, excellent/unique opinion, high-quality photographs, attractive writing style, good layout, and lots of thumb-ups/shares from others (Wu et al. 2015; Zhou et al. 2016; Li 2017; SUN 2017).

Since this is a survey from the users' perspectives, a two-step cluster analysis was applied to group the participants by their post-reading actions (thumb-ups and shares, Items 9 and 10) and then explore the role of different factors (e.g. appealing photographs) here. Motivations for giving thumb-ups and sharing the article appeared together here as the alternatives because both of them are post-reading actions and closely related to each other.

The next item (Item 11) directly tested the potential actions after reading WeChat articles with appealing photographs. Alternatives of this item were different levels of engagement: (i) no action at all, (ii) giving a thumb-up in mind (enjoyed but without any action, i.e. moral support), (iii) giving a thumb-up, and (iv) sharing the article. Compared with Items 8 to 10 that involved a series of factors/motivations, this item focused on post-reading actions with appealing photographs specifically. The result of this question could potentially explain the clusters of participants.

Apart from the multiple selection items above, I also examined the potential specific relationship between the aesthetic quality of photographs and reading experience through the last item (Item 12). The alternatives here were a selection of visual attributes of

photographs. Participants were asked to choose up to three aesthetic attributes most negatively affected the appeal of a photograph in WeChat articles about nature.

This online survey has been approved by the University of Otago Human Ethics Committee (ID: D18/228, see Appendix K). Participants of the survey were recruited mainly through WeChat, as the targeted participants were WeChat users. The online questionnaire was generated by wj.qq.com, which is also a product of Tencent Holdings Ltd, China. The questionnaire was easily completed via smartphones, and its hyperlink could also be integrated into a QR code which could be added onto WeChat articles with recruitment information. The author's own WeChat Public Account (*Birdslife*, which is about birds and conservation in China and New Zealand) also pushed the questionnaire to all the followers. A few students, bird watchers, naturalists and conservationists in China also helped spread it. In addition, some respondents were recruited on the street in Yunnan Province and Beijing, China via scanning the QR code that contained the hyperlink of the questionnaire. A pilot study was carried out with six participants, so as to ensure the questions are easy to understand and can be completed within a few minutes. Minor revisions were made according to suggestions of participants. The field survey was conducted from August 2018 to October 2018. The statistical analysis was done with the Statistical Product and Service Solutions (SPSS) Version 24.0.

The topic of the targeted WeChat articles here is nature (i.e. interpretive science stories about nature). To avoid potential bias from personal interests when testing the attractiveness of photographs, the participants' interests in nature were examined and grouped. Respondents were divided into three groups according to their interests in nature: (i) those have a specialised interest in nature and are knowledgeable in one or more fields such as birds (SN), (ii) people with a general interest in nature but do not have much experience and specific knowledge in nature (GN) and (iii) those are not interested in nature (NN) – they profess not to care about nature and biology much if at all. All the judgement above were based on self-assessment in the questionnaire.

7.3. Results

7.3.1. Section A: demographics and reading habits

A total of 1,087 participants completed the online questionnaire. However, seventy-four of them had never read interpretive popular science WeChat articles about nature, so they did not have any experience in terms of this topic. As I aimed to analyse the role of photographs in interpretive WeChat articles based on the participants' experience of reading, the answers from these seventy-four participants were, therefore, dropped. The usable sample size was 1,013. The socio-demographic variables, which showed the characteristics of participants, were illustrated in Fig. 7.1. All the respondents who chose the alternative "I am not sure/I would rather not say" for demographic and specific items were also included in the results as "others".

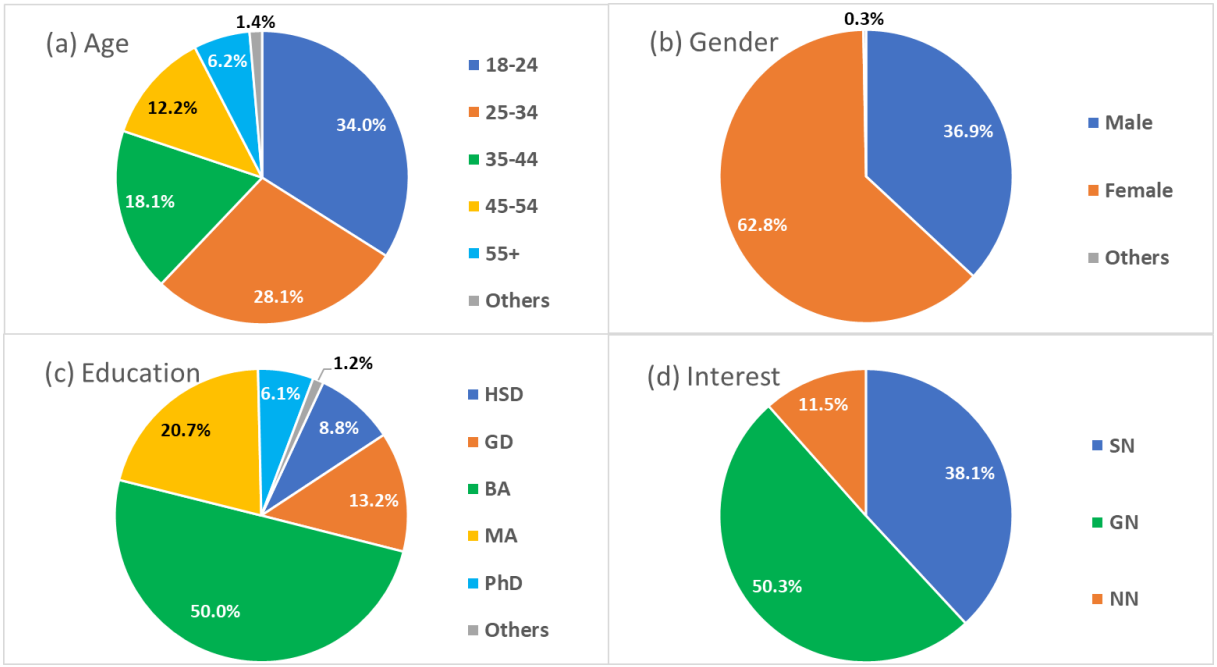


Fig. 7.1 Demographic summaries, n = 1,013. The alternative "Others" means the statement "I am not sure/I would rather not say" in the questionnaire. For education levels, HSD means a high school diploma, GD means a college or graduate diploma, BA means a bachelor, MA means a master or postgraduate diploma. For the interest groups, SN, GN and NN represent the participants who are specialised nature enthusiasts, generally interested in nature and not interested in nature, respectively.

Age groups of the participants showed that 62.6% of them were under the age of thirty-five. This could be explained by the characteristics of WeChat users: according to the results of a Chinese survey on social network users (mainly WeChat users) in 2016, 53.7% of them were under the age of thirty. As to the sex ratios, the number of female participants was much larger than males. This trend was in line with the sex ratio of the followers of my own public account *Birdslife*, as the majority of participants were recruited through this public account. Also, Sax et al. (2003) indicated that women were 1.8 times more likely to respond to Internet-based surveys than men. Also, participants in this survey showed an amazingly high education level: 91.1% of the participants had completed tertiary education (graduate diploma, bachelor, master or PhD), which was much higher than the average data for China (National Bureau of Statistics of China 2017). The well-educated sample was potentially related to their interests in nature and biology: of all the participants in the survey, 88.4% were interested in nature to some extent (SN or GN), and the majority of them showed an interest in birds (59.9%, tested by Item 5). According to a survey by McFarlane and Boxall (1996), well-educated people tended to be in interested birds: as high as 74.8% of the casual birdwatchers were university-educated, and the proportion was even higher (85.7%) for advanced birdwatchers. It should also be noticed that the large proportions of SN and GN were probably not reflective of the whole population in China. This is because the participants were recruited mainly through WeChat Public Accounts about nature. It is thus not surprising that the majority of the participants, as the followers of such public accounts, were interested in nature.

7.3.2. Section B: how do photographs influence the performance of interpretive WeChat articles?

The first item in section B (Item 8) tested the most important factor that motivates users to read a popular science WeChat article about nature. Based on the design of WeChat, the users are able to see three elements of a certain article before reading: the title, the cover image as well as the public account or the person who pushed or shared it (see also Section 2.5.2.1). Results demonstrate that the most vital factor is an attractive title, which was chosen by 62.2%

of all the participants. Moreover, 19.2% of the participants stated that an appealing cover image was the first factor taken into account. Only 11.2% of the users thought the author (including public account/person who shared the article) was more important than other elements, followed by 7.5% of the participants who chose “other factors”.

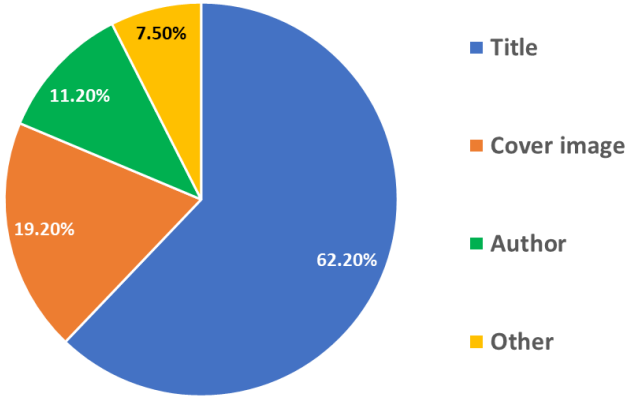


Fig. 7.2. Factors that may motivate WeChat users to read a popular interpretive science WeChat article, n = 1,013.

The focus of Items 9 and 10 was on the relationship between the elements in WeChat articles and the possible reactions (thumb-up and share) after reading. A few elements potentially influenced the users’ reactions such as attractive writing style, good layout and appealing photographs were given as alternatives. The participants were divided into two distinct clusters (see Table 7-1) by their choices. Cluster 1 contained 298 respondents, which comprised 29.4% of the total sample population, while Cluster 2 included the rest of 715 participants (70.6% of the total). Cluster 2 was apparently the larger cluster.

Table 7-1 Cluster solutions and distributions of post-reading reactions (2-step cluster analysis by SPSS 24.0). Based on Item 9 and 10 in the questionnaire: *choose up to three most important factors that motivate you to give a thumb-up (and share) a WeChat article about nature*, n = 1,013. Percentages under a cluster represent the proportion of participants who chose a certain factor/motivation to all the participants in this cluster.

Action	**Factor/Motivation**	**Cluster1 (29.4%)**	**Cluster2 (70.6%)**
Thumb-up	In-depth/Useful content	99.7%	87.7%
Share	In-depth/Useful content	95.2%	89.9%
Thumb-up	Excellent/Unique opinion	97.6%	9.3%
Share	Excellent/Unique opinion	94.8%	39.6%
Thumb-up	Attractive writing style	42.9%	67.3%
Share	Attractive writing style	37.4%	51.4%
Thumb-up	Appealing photos	22.1%	55.8%
Share	Appealing photos	17.0%	39.0%
Thumb-up	Good layout	11.4%	33.8%
Share	Good layout	7.6%	21.3%
Thumb-up	Attractive title	5.5%	20.4%
Share	Attractive title	9.3%	22.1%
Thumb-up	Other factors	4.8%	2.9%
Share	Other factors	0.3%	1.5%
Thumb-up	Lots of thumb-ups from others	1.0%	1.0%
Share	Lots of shares from others	2.4%	1.8%

According to Table 7-1, the participants in Cluster 1 emphasised the opinion and depth of the content of interpretive WeChat articles: they preferred in-depth and useful information, including those excellent or unique opinions in the article. Specifically, 97.6% of the participants in Cluster 1 agreed that they would give a thumb-up for a WeChat article with excellent or unique opinions, and 94.8% of them would share such an article. Moreover, most of the participants in Cluster 1 (99.7%) would give a thumb-up for an article with in-depth or useful content. The role of visual and expressive elements such as photographs, layout and writing style seemed not to be very important for the participants in this cluster (chosen by less than 50% of the participants in Cluster 1). In summary, they were interested in what the article presented but did not care much about the way of presenting.

For Cluster 2, participants also liked in-depth or useful content, the proportions of participants who selected these alternatives ranged between 85% and 90% for both thumb-up and share, which were just slightly lower than those in Cluster 1 (around 90% or even

higher). However, only 9.3% and 39.6% of the participants in Cluster 2 would like to give a thumb-up and share the article because of its excellent/unique opinion, suggesting a significant difference with Cluster 1. Also, in contrast with Cluster 1, the participants in Cluster 2 were more interested in visual and expressive elements, as 55.8% of them tended to give a thumb-up for a WeChat article with appealing photographs, and 67.3% for giving a thumb-up for an attractive writing style. In addition, even though only 33.8% and 39.0% of the users in Cluster 2 would leave a thumb-up for good layout and share the article because of the outstanding photographs, respectively, the above proportions were still much higher than those for Cluster 1 (11.4% and 17.0%, respectively). In summary, participants in Cluster 2 concerned not only whether the content was helpful but also how the article was expressed (i.e. visual elements and writing styles). The photographic elements seemed to be more important for the participants in Cluster 2 than those in Cluster 1. Additionally, in terms of the responses towards the appealing photographs, more users preferred to merely give a thumb-up rather than share the article in their WeChat Moments when they had realised the photographs in the article were outstanding.

As to the characteristics of participants in the two clusters, they did not have any significant difference in age groups (Chi-square = 5.48, $p = 0.360$), genders (Chi-square = 1.31, $p = 0.519$), education levels (Chi-square = 6.57, $p = 0.255$) and interests in nature (Chi-square = 1.61, $p = 0.447$). However, the Chi-square test suggested that their preferred length of popular science WeChat articles had different distributions (measured by Item 7: how much time they spend on reading an interpretive WeChat article, Chi-square = 46.36, $p < 0.001$, see Fig. 7.3). Specifically, the participants in Cluster 1 preferred longer WeChat articles (higher proportion in the group of five to ten minutes and the group of ten to fifteen minutes), while the participants in Cluster 2, who focused more on visual elements than the depth of content, were happy with shorter WeChat articles (reading time less than five minutes).

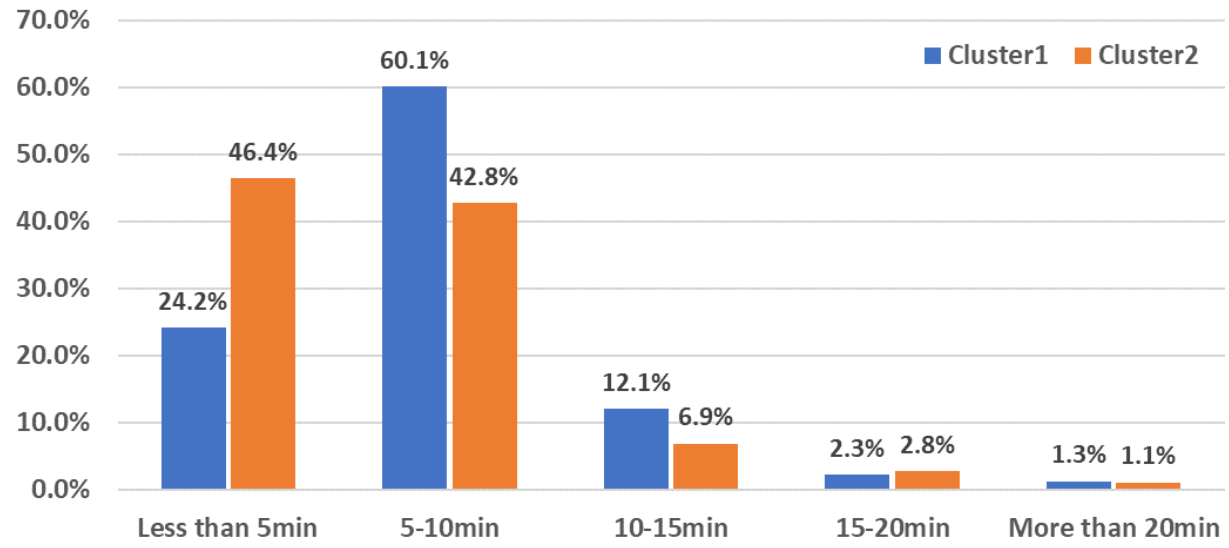


Fig. 7.3 Distributions of the two clusters by reading time (length). The participants in Cluster 1 and Cluster 2 had different preferred lengths of WeChat articles about natural science (measured by time spent on reading an article).

The next item of this section directly tested whether the visual appeal of photographs (reflected by visual quality here) was related to the reactions after reading (Item 11: *If you found a WeChat article about nature appeared with high-quality photographic images, what will you do?*). Preferences for different reactions were presented in Table 7-2. Obviously, the participants tended to leave a thumb-up (34.3%) or just give the moral support/emotional responses (37.7%) if they saw the appealing photographs in a WeChat article, while 24.2% of them would like to share an article because of the use of high-quality photographs. Only 3.8% of the participants thought the use of high-quality photos did not affect their reading experiences at all.

Table 7-2 Item 11: Reactions of WeChat users when they read an interpretive WeChat article about nature with appealing photographs, n = 1,013.

Alternatives of Item 11	**Proportions**
Do nothing, because appealing photos do not affect my reading experience.	3.8%
Do nothing, but I will give a thumb-up in mind (moral support only).	37.7%
Click the “thumb-up” for this article because of these appealing photographs.	34.3%
Share this article in my WeChat Moments because of these appealing photos.	24.2%

As a supportive item for the cluster analysis above, Item 11 confirmed the link between post-reading reactions and high-quality photographs in a more specific and detailed way. The

clusters had a significant influence on the results of Item 11 (Chi-square = 14.44, p = 0.002): more participants in Cluster 2 preferred to give a thumb-up (36.8% of the Cluster 2) and share (25% of the Cluster 2) than those in Cluster 1 did (28.2% for thumb-up and 22.1% for share, respectively), see Fig. 7.4. Compared to Cluster 2, the participants in Cluster 1 did not show the tendency of giving any real positive response to high-quality photos. Nevertheless, 43.6% of them indeed had positive emotional responses by these photos (giving thumb-ups in mind/moral support).

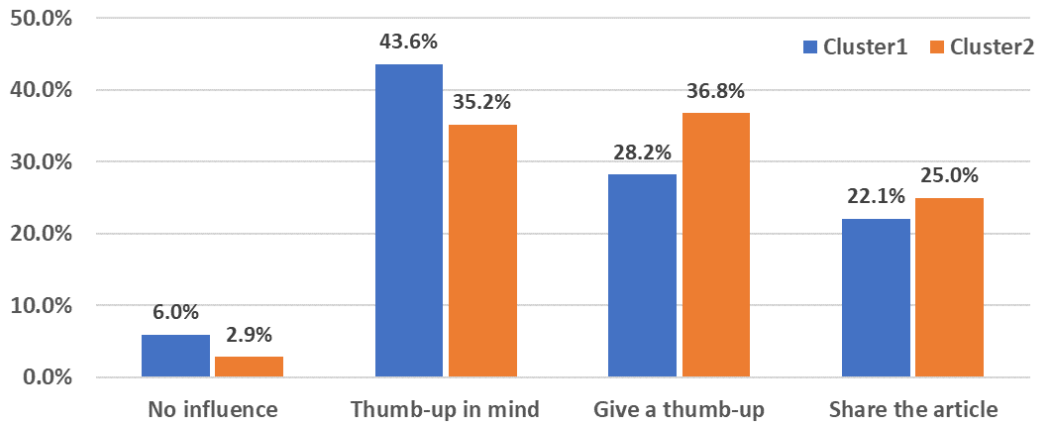


Fig. 7.4 Distributions of the two clusters by post-reading actions with high-quality photographs. *No influence* means the alternative "I will do nothing, and I do not care, because appealing photos do not affect my reading experience at all". *Thumb-up in mind* means the alternative "I will do nothing, but I will give a thumb-up in mind" (moral support only). *Give a thumb-up* means the alternative "I will click the thumb-up button under this article because of these appealing photographs". *Share the article* represents the alternative "I will share this article in my WeChat Moments because of these appealing photographs".

The last item (Item 12) focused on the value of visual attributes of photographs for the interpretive WeChat articles about natural science: *choose up to three aesthetic attributes most negatively affected the appeal of a photograph in WeChat articles about nature.* Results suggest 89.7% of the total respondents recognised that at least one poor attribute negatively affected their reading experience (see Fig. 7.5). Amongst the attributes involved, colourfulness became the conspicuous factor, which was referred by 28.6% of the participants across the three interest groups. Also, 25.9% of the participants chose action/narrative, followed by composition (25.8%), exposure (23.1%) and saturation (20.5%). Regarding the influence of the participants' interest in nature, the preference for colourfulness and action/narrative were significantly affected by interests (Chi-square =

58.75, $p < 0.001$ for colourfulness, Chi-square = 39.82, $p < 0.001$ for action/narrative). Specifically, SN concerned more about action/narrative (36.8%) than others did. A number of GN and NN disliked colourless primary subjects in photographs (37.5% for GN and 35.9% for NN). SN, by contrast, did not care much whether the subject was colourful or not (14.8%).

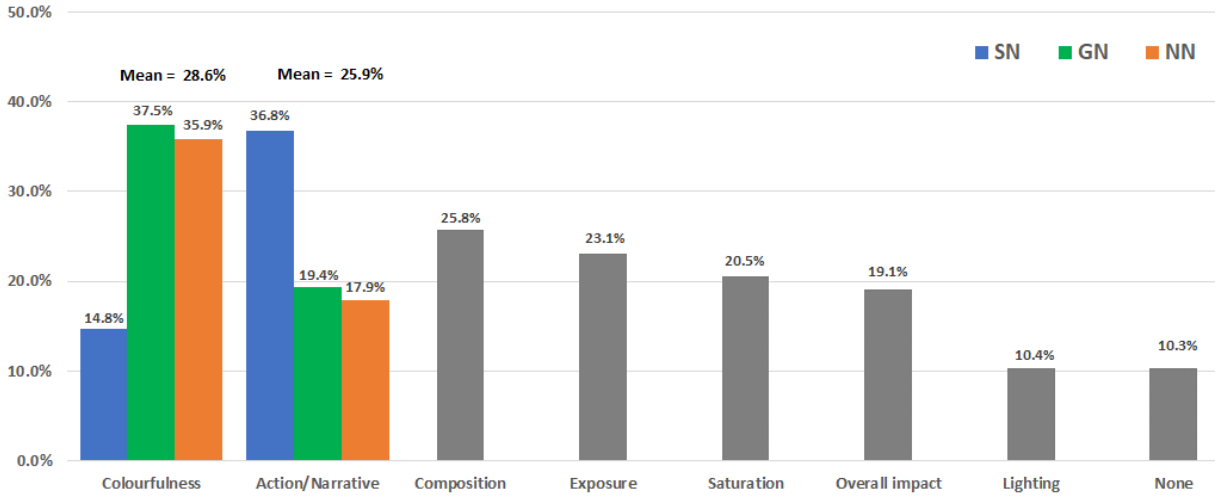


Fig. 7.5 The most disliked poor aesthetic attributes of photographs in WeChat articles, n = 1,013. The first two attributes two (colourfulness and action/narrative) are varied by the interest of participants in nature, while the other six attributes plus the alternative "none of them" are not influenced by the interest groups. The percentages of the participants who chose a certain attribute for the total sample are given (the grey bars). For the first two attributes that are affected by interests, the proportions within each interest groups are given separately. For interest groups, SN (blue) represents participants with a specialised interest in nature, GN (green) represents participants with a general interest while NN (orange) represents participants who are not interested in nature.

7.4. Discussion

7.4.1. Title and cover image: motivation for reading a WeChat article?

Whether or not to read a WeChat article is the first decision that WeChat users have to make when they have seen such an article. Intention to read is thus one of the most important factors affecting the performance of WeChat articles (Jing & Wei 2016). In this information-overloaded era, individuals need to process unlimited information with their limited time and attention, and this has been a significant issue for the users of the online social media applications such as WeChat (Hodas & Lerman 2012; Rodriguez et al. 2014; Harwit 2017):

why do I have to spend some time reading the article? WeChat users, therefore, need a reason to click the link of a WeChat article.

In the context of interpretive WeChat articles about natural science, I examined three factors that potentially motivate a WeChat user to read the article: the title, the cover image and the author/account. Responses from participants clearly suggest an attractive title is the most important factor. This finding is consistent with another research on WeChat articles, which indicated the significance of titles and discussed the specific performance of different types of titles based keywords and semantic analysis (Wu et al. 2015). Furthermore, a good title is recommended not only for WeChat articles but also for a variety of online reading materials, which is reflected in the following two aspects. First, a proper title contains the key point or the topic of the subsequent article, which helps the audience predict or retrieve the content of the article in a short period of time (Kutz & Herring 2005; Wu et al. 2015). For example, based on an information retrieval analysis with the online news from a few popular websites such as Cable News Network (CNN) and the British Broadcasting Corporation (BBC), Kutz and Herring (2005) found individuals are able to identify what the story is about and track the progression of an event easily through the titles of the online news from CNN and BBC. Secondly, a good headline can grab the readers' attention and attract them to read (i.e. click) the subsequence content (Wu et al. 2015; Chakraborty et al. 2016). By means of this, the performance (e.g. pageviews) of an online article can be improved. Aiming to explore the relationship between the title and the popularity of the online article, Stokowiec et al. (2017) develop an approach to predict the performance of the online content using only its title. However, Chakraborty et al. (2016) claimed that the readers might be tricked and disappointed by a few catchy titles: sometimes the subsequence story does not meet the expectation of the readers, or the content is even not relevant to the title. In summary, even though there are criticisms (Chakraborty et al. 2016), a proper and attractive title is still the most important factor taken into account for producing interpretive WeChat articles.

Apart from the title, an appealing cover image was the second most important factor for the intention to read the articles: nearly one-fifth (19.2%) of the participants stated they would

read an article because of an attractive cover image. Even though the cover images do not only include photographs, photographic images are still one of the most widely-used images for the cover. The importance of cover images may be explained by two aspects: First, an appealing image is apparently a positive visual stimulation (Sugano et al. 2014), which helps to get users' attention (Houts et al. 2006). In my previous survey on the efficacy of photographs on interpretive signage for science communication, I confirmed an appealing photograph (with high visual quality) was able to grab tourists' visual attention and attracted them to read the signage (Chapter 6). Second, an attractive cover image may give users a positive first impression of the subsequent science story. For example, when interpreting the conservation of an endangered bird that is unfamiliar to the public, an appealing and informative cover image helps to show people what the bird looks like and how beautiful/cute/unique it is. The example above corresponds to two important roles of photographs in interpretive materials: (i) showing the real status of the natural attraction (e.g. wildlife, landscape, vegetation, etc.), and (ii) presenting the above natural attractions aesthetically (Department of Conservation 2005; Husain et al. 2017). In addition to the title and the cover image, the author or the public account who posted or shared the article was taken into account by a minority of participants. Similarly, Zhou et al. (2016) indicated that the poor performance of a number of public accounts did not match the good reputation and popularity of the organisation running these accounts. For example, China Association for Science and Technology (CAST), as the largest and the most famous organisation of professionals in the field of science communication in China, still had room to improve the performance of its own public account *China Popular Science* (Zhou et al. 2016).

7.4.2. The influence of high-quality photographs on post-reading actions

Post-reading social reference actions included a variety of actions in the context of WeChat, but only thumb-up and share were widely used to assess the performance of an article (Lee et al. 2015; Zhou et al. 2016; Li 2017). The cluster analysis clearly demonstrates the importance of each combination (post-reading actions and their motivations, e.g. thumb-up for appealing photographs) for the two clusters: the participants in Cluster 1 tended to focus

on the textual content (excellent/unique opinion and in-depth/useful content), while the participants in the much larger Cluster 2 also preferred in-depth/useful content but concerned more on visual and expressive elements. Giving a thumb-up for good photographs in the article was the most preferred reaction for Cluster 2 in this respect.

It should be noted that the visual element (e.g. high-quality photographs) was not a requirement for the smaller Cluster 1. Instead, they evaluated the depth and usefulness of the content, as well as the opinion expressed in the article. The characteristics of the participants in this cluster thus go against the mantra of science communication theory and practice in terms of the role of visual elements (see also the findings of Chapter 6) that emphasises the importance of visualisation for science communication (Trumbo 1999; Betts & McNaughton 2003; Brath et al. 2005). A possible explanation is the specific expectations of the readers when they read a WeChat popular science article. Li (2017) conducted a Chinese study on the attitudes of the university students towards the content of the WeChat Public Accounts about science. Her results suggested that the actual usefulness (judged by the participants) of the content did not meet the expected perceived usefulness (also judged by the participants), meaning that these students had high expectations for the usefulness of the content. By contrast, they had lower expectations in terms of the perceived fun and the use of visual elements (Li 2017). Therefore, this group of people (e.g. university students in the study above and Cluster 1 in my study) clearly know what information is expected to be delivered by a popular science article. For such readers, the high expectation for the textual content (e.g. usefulness, depth or point of views) becomes the most important motivation to read an interpretive WeChat article about science, while the visual elements did not much influence their specific expectations and reading experience. However, it is important that Cluster 1 here is much smaller than Cluster 2, which still shows visualisation (e.g. high-quality photos) is important for the majority of the participants.

It has been suggested that science should be communicated in an enjoyable and visual way to increase people's interest and improve the effectiveness of communication (Burns et al. 2003; Brath et al. 2005; Pauwels 2006), and this is especially important for popular science

WeChat articles, because lack of visualisation has already been an existing problem limiting the performance of this type of articles (Zhou et al. 2016). Despite the existing literature, the importance of visualisation for popular science WeChat articles was also emphasised by the results in this chapter: the majority of WeChat users (Cluster 2) could indeed be impressed by visual elements, especially those outstanding photographs, in a popular science WeChat article. The results, therefore, reflect that science communicators need not only to attempt to visualise the interpretive content but also to enhance the visual appeal of such elements. By means of that, a popular science WeChat article is likely to receive more positive post-reading reactions (thumb-ups here). With more such positive reactions being given, the performance of a WeChat article would be better. As a result, both the users' enjoyment and their willingness to follow the public account who pushed the article will be improved (Li 2017).

In addition, participants' preferences for visual elements were also related to their preferred length of time for reading a WeChat article. Generally, over 80% of the participants in both clusters opted to spend less than ten minutes reading a WeChat article. This is probably because the participants would like to get as much information as possible with their limited attention and available time, instead of spending too much time on one article (Romero et al. 2011; Weng et al. 2012; Tencent 2017). Interestingly, participants in Cluster 2 preferred shorter article (less than five minutes as the most preferred alternative) than Cluster 1 did. Such a tendency might be associated with their preference for visual elements such as appealing photos: as suggested by my previous survey on the interpretive signage within national parks, an appealing photograph could enhance the reading engagement and understanding (Chapter 6). With those appealing photographs (determined by their high visual quality), individuals are, thereby, able to improve the efficiency of reading the interpretive information about science within a relatively short time.

As discussed above, the effectiveness of using high-quality photographs is linked with participants' positive post-reading actions. Furthermore, this type of reaction, such as thumb-ups, is an important part of assessing the performance of a popular science WeChat article

for communication science (Zhou et al. 2016; Li 2017). The positive relationship between the social reference actions (e.g. thumb-ups) and the performance of the relevant material (e.g. WeChat articles) have also been found in a similar online social media platform: Facebook. Lee et al. (2015), on the basis of their social commerce research, stated that Facebook likes (also known as thumb-up) for the information interpreting characteristics of products were positively related to sales, though this link was moderated by a wide range of contextual factors. The study above reveals the importance of post-reading social reference actions for the performance of online material.

The question about the specific response after reading WeChat articles with appealing photos (Item 11) provided the opportunity to interpret the results of the cluster analysis from the perspective of reading engagement. This finding not only confirmed participants in Cluster 2 indeed preferred to give positive responses (e.g. thumb-ups) to the articles with appealing photographs, but also revealed that those in Cluster 1, who seemed to care about the textual information only, could also be impressed by appealing photos: only a minority of Cluster 1 (6.0%) stated their reading experience was completely irrelevant to the visual appeal of photographs, and nearly half of them (43.6%) had positive emotional responses to those appealing photos (i.e. giving a thumb-up in mind). Such emotional responses cannot be shown by the cluster analysis directly, but it indeed exists: visual quality is playing significant roles across both clusters, though participants in the two clusters preferred different types of responses.

Unlike those post-reading reactions such as thumb-ups or shares, the emotional response does not contribute to the dissemination of the information directly, but it is still an important aspect of the effectiveness of the WeChat article for science communication. Specifically, such positive affective responses show that people enjoy appealing photographs, reflecting a link between the visual appeal of photographs and reading engagement. Such a link has been confirmed by my previous survey in Chapter 6 within the context of the interpretive signage.

7.4.3. Visual attributes of photographs in WeChat articles

Aesthetics is a vital aspect when assessing the appeal of photographs (Datta et al. 2006; Caivano 2008; Redi & Povoa 2013). There are a number of visual attributes affecting the aesthetics of a photograph (Li et al. 2010b; Su et al. 2011; Lišková & Frynta 2013; Aydın et al. 2015). In this survey, the results of Item 12 presented how different visual attributes affect the perceived visual appeal of the photographs in interpretive WeChat articles. Most participants (89.7%) recognised that at least one visual attribute affected the perceived appeal of the photographs. The most concerned attributes based on the results were colourfulness, action/narrative, exposure and composition, amongst which colourfulness was the most conspicuous attribute. In the previous study on individuals' perceptions of the visual attributes of the photographs of birds (Chapter 4), I found that the colourfulness of the subject (birds) is a vital factor when the participants evaluate the visual appeal of a photograph.

The participants' interest in nature also plays a role in this survey: all the three interest groups (SN, GN and NN) reached consensus to their perceptions of five attributes (composition, exposure, saturation, overall impact and lighting), while their preferences showed significant differences within the following two groups: colourfulness and action/narrative. Especially, those SN, known as knowledgeable nature enthusiasts, showed an amazingly poor interest in colourfulness but concerned action/narrative, which was contrary to the results of GN and NN. The result in Chapter 3 was similar: when assessing the visual appeal of a photograph of birds, those specialised and knowledgeable bird watchers tended to examine (i) whether the photographs could express a certain emotion or tell a behavioural or ecological story, (ii) if the subject (i.e. the bird) was locally representative, (iii) if the action of the bird in the photo was interesting or difficult to capture, whereas the colourfulness of the subject was not a priority. By contrast, participants with a general or no interest in birds focused more on the aspects such as sharpness, lighting condition or exposure, especially colourfulness. As explained in Chapter 3, the different preferences across the three interest groups probably because those specialised enthusiasts (SN in this chapter, or the bird enthusiasts in Chapter

3) are more knowledgeable in the relevant area, which can support them to concern more about emotional, behavioural and ecological aspects of a nature photograph. The results of this chapter suggest that the interest of the targeted audience should be seriously considered when choosing photographs used in interpretive WeChat articles about natural science.

7.5. Conclusion and implications

In the context of the most successful social media platform in China: WeChat (Statista 2019), the present study identified the value of using appealing photographs in WeChat Public Account articles for interpreting science stories about nature. The effectiveness of science communication in this study was measured through three indicators: the users' willingness to read a WeChat article as well as two post-reading social reference actions: thumb-ups and shares. Results based on the participants' intention to read the articles reveal that the attractiveness of the cover image is the second most important factor motivates people to read an interpretive WeChat article, while the most important element here is the title of the article. Results also suggest that individuals' perception of the overall quality of the article is closely related to post-reading social reference actions: most participants recognised that the use of appealing photographs could indeed enhance their reading experience and the majority of them would give a thumb-up because of the use of such photographs in popular science WeChat articles. It can be concluded that the effectiveness of the interpretive natural science WeChat articles for science communication can be improved by the used of appealing photographs because such images not only get users' attention (improve willingness to read) but also enhance the experience of reading (reflected by the positive post-reading actions).

This chapter also examined the role of visual attributes of photographs used in popular science WeChat articles. Generally, most participants pointed out at least one aesthetic attribute could affect the visual appeal of photographs. Amongst a selection of visual attributes, sharpness was identified by the participants as being the most important element for the visual quality of photographs, followed by action/narrative, composition and

exposure. The preference for visual attributes was also partly influenced by participants' interest in nature. Those SN did not like photographs with poor action/narrative, but they were dismissive of colourfulness, whereas GN and NN stated colourfulness is important for photographs but did not care much about action/narrative.

This is the first research looking at the role of photographic elements in the context of WeChat Public Account articles, especially those of interpretive content about natural science. Results show the specific importance of photographs for improving the effectiveness of online interpretive products for science communication. The findings enable authors of WeChat articles to select and use photographs appropriately and provide an approach (i.e. using appealing photographs) to resolving the issue of the interpretive WeChat articles about natural sciences.

Chapter 8. Summary of Findings and General Discussion

8.1. Introduction

A national park is an ideal location to undertake communication about natural sciences through appropriate interpretation (Fritz 2009; Mearns & Botha 2017; Department of Conservation 2018). Successful interpretation within such parks is important for both tourism (e.g. visitors' experiences) and communication of science and conservation (Tubb 2003; Department of Conservation 2005; Ismail 2008; Munro et al. 2008). To improve such interpretation, photography is suggested as a potentially useful visual element (Frankel 2001; Carr 2012; Husain et al. 2017). Photographs have been shown to be a helpful visual component when interpreting science, and they are also able to engage attention, evoke emotional responses and improve individuals' understanding of the relevant content (Trumbo 2000; Betts & McNaughton 2003; Husain et al. 2017).

However, up till now, there was a lack of empirical studies on whether and how the visual characteristics of photographs (e.g. subject and visual quality) influence the effectiveness of communication. A better understanding of this topic should help with selecting and using photographs more effectively within national parks in order to enhance the effectiveness of nature interpretation. Within the context of national parks, this project aimed to test: (i) for the photographs of the natural attractions within national parks, how the visual characteristics of these photographs contribute to their perceived attractiveness, and (ii) within the context of two interpretive products that may be used within national parks: signage and WeChat, how the use and the visual characteristics of a photograph influence the effectiveness of interpretive materials for science communication. Results were presented and interpreted in Chapter 3 to Chapter 7. Here I summarize the findings of my research in accordance with the aims above. After that, a few limitations and potential further extensions to my research are discussed, followed by an overall conclusion of this thesis.

8.2. The use of photography for science communication: always better than using text only?

Generally, using illustrations such as photographs to visualise science has been considered as an important means to help communicate science more effectively (Frankel 2001; Pauwels 2006; Serafini 2011; Husain et al. 2017). However, even though the role of visual quality and the subject of a photograph has been briefly acknowledged by a few researchers (Frankel 2001; Carr 2012; Husain et al. 2017), the significance of the above visual characteristics of images has received little attention in the field of science communication. Most science communicators still believe that adding images will help to communicate science stories, and this is indeed supported by a series of studies as reviewed in Chapter 2 (Austin et al. 1995; Trumbo 1999; Houts et al. 2006).

According to my results in Chapter 6, compared to the interpretive signage without a photograph, the signage with a photograph elicited better understanding and recall of information that was apparent from the photographs. Specifically, the high-quality one was more effective (see the knowledge test section in Chapter 6). This finding shows the importance of visualisation for science communication: photography can present natural science (e.g. wildlife, landscape or the interaction between human and nature) objectively, and thereby enable the public to understand the real status of nature more easily (Department of Conservation 2005; Caivano 2008; Husain et al. 2017).

The findings of this thesis suggest the interpretive materials with images are not necessarily more attractive and effective than those without images: it is the visual quality of the photograph that matters. The results in Chapter 3 and Chapter 4 show that when observing nature photographs, individuals were only engaged by appealing ones (i.e. high visual quality, sharp/colourful subjects, *etc.*), suggesting that photographs perceived to be poor may not contribute much, if anything, to communication. Moreover, within the context of interpretive signage (Chapter 6), participants were more likely to read the signage only if the signage included an appealing (high-quality) photograph. When the visual quality of the photograph

on the signage was poor, it produced significantly lower intention to read the signage by participants than even the control group without photographs. Also, there was no significant difference in engagement between the signage with a poor-quality photograph and the signage without a photograph (i.e. the control group), in contrast significantly higher engagement reported with signage containing high-quality photographs. Thus, the influence of the presence/absence of photographs for the effectiveness of communication is not as significant as the influence of visual quality, especially in terms of emotional responses.

A possible explanation is that photography is often considered as a form of the visual arts, and the visual quality (aesthetics) and characteristics of the subject are, therefore, vital features determining whether or not a photograph is attractive (Li et al. 2010a; Curtis et al. 2012). From a psychological perspective, Silvia (2005) noted that things perceived as appealing art forms (e.g. high-quality photographs) could evoke positive emotional responses, including interest and enjoyment. This explanation is also confirmed by the results in Chapter 3. My research provides strong support for the proposition that photographs are most effective for science communication when they are of high perceived visual attractiveness. The next section explains the specific implications of the visual characteristics of a photograph for its perceived attractiveness based on the results of this thesis.

8.3. Being attractive: the value of visual characteristics

This thesis found both the visual quality and the characteristics of the subject are vital influencers of the perceived attractiveness (measured by participants' preferences) of a nature photograph. First, the visual quality of a photograph is closely related to participants' perceived attractiveness of the photograph. Outstanding nature photographs can successfully get the participants' attention (Chapter 3 and Chapter 6). Similarly, a few other studies also showed the visual quality of photographs significantly influence an observer's visual attention (Redi & Povoa 2013; Sugano et al. 2014). A possible explanation is that observers have some common preferences for a few visual attributes when judging the visual appeal

of a photograph, which was confirmed in Chapters 3 and 4. For example, participants could easily judge whether a photograph is sharp and colourful when explaining why they liked or disliked a given photograph.

It is noteworthy that visual quality is not the only factor that determines the perceived attractiveness of a photograph. The influence of the subject is also significant. In Chapter 3, the Factors 2, 3 and 4 (all related to subject) in factor analysis explained a total of 44% of the variance, which reflects how the subject of photographs affect the preferences of participants. Specifically, photographs of birds (Factor 2), iconic landscapes (Factor 3) and wetland-related subjects (Factor 2) were appreciated by participants. Preferences of visitors for subjects can be explained by their personal preferred local activities or nature attractions (Hvenegaard & Dearden 1998; Fairweather & Swaffield 2001). A study of tourists' preferences for photographs of Kaikoura, New Zealand found that tourists' interests in local natural attractions and activities significantly influenced their liked and disliked photographs: for example, ca. 22% of the participants were interested in maritime recreation, and they preferred the photographs of local maritime recreational activities (Fairweather & Swaffield 2001). Similarly, in Chapter 3 of this thesis, all the participants loaded on Factor 2 (Local Birds Encounter) are those interested in birds to some extent (having a specialised or general interest in birds, i.e. SB or GB). According to the explanations of the participants, their interest in nature and local experience (i.e. preferred activities within the park) significantly influenced whether they were interested in a certain photograph. The above findings confirm that the intended audience's interest in the subject should be considered when using photographs to interpret stories about science. This is supported by Marchesotti et al. (2011), who suggested not only does visual quality affect the perceived attractiveness of a photograph, but that the observers' personal taste plays an important role.

Tourists showed their preferences not only for nature photographs of different types of subjects but also for the same type of subject (e.g. wildlife) with different detailed characteristics. For a photograph of a bird, for example, the colourfulness, morphological traits (e.g. a bird with a long tail), behaviour and ecology are important aspects that draw

observers' attention (for details see Chapters 3 and 4). Similarly, Lišková and Frynta (2013) suggested that people preferred birds with larger eyes, shorter necks and longer tails. Marešová et al. (2009) also reported that the perceived attractiveness of photographs of species of milk snake was related to the colouration of the subject (i.e. the snake). Hence, for science communicators within national parks, integrating the photographs of visually attractive natural attractions into interpretive materials is likely to be an effective means to enhance communication, because both high visual quality and having an attractive subject contribute to the perceived attractiveness of the photograph. Next, I present the specific implications of a perceived attractive photograph for natural science communication.

8.4. Implications of appealing photographs for science communication

Using two widely-used interpretive products (interpretive signage within national parks and online WeChat articles), I examined how the effectiveness of nature interpretation may be influenced by using photographs with varied visual characteristics. The effectiveness of interpretive material for communication was measured based upon three dimensions: affective outcomes, cognitive outcomes and behavioural outcomes (Ham & Weiler 2006). However, because the interpretive content in this project (i.e. introductory descriptions of the local birds in Chapter 5 and the Common Kingfisher in Chapter 6) did not involve any information about changing behaviours, the behavioural outcome was not the focused aspect of the effectiveness in this project. Results showed that a photograph that was perceived as appealing could enhance communication about science and nature on both affective and cognitive outcomes.

8.4.1. Affective outcomes

An audience's positive emotional responses to interpretive materials such as appreciation, engagement and interest are an important aspect when evaluating the effectiveness of science communication (Burns et al. 2003), because such positive emotions can motivate the general public to acquire more relevant knowledge and may also increase public understanding of

the relevant topic (e.g. conservation) (Thorlacius 2002; Tisdell & Wilson 2004). Similarly, when interpreting science stories within national parks, such responses, which are also named as affective outcomes, are considered as key outcomes as well (Ham & Weiler 2006).

In this thesis, the emotional response of participants to the study material (photographs and interpretive products with photographs) was reflected by a series of variables: (i) their attention and appreciation (Chapters 3, 4 and 6), (ii) intention to read the interpretive signage (Chapter 6), (iii) potential increase in their interests in the topic interpreted and (iv) enjoyment of reading (Chapters 5, 6 and 7). The results show that all the above responses are closely related to participants' perceived attractiveness of the photographs used in the survey. For example, in the Q method interviews in Chapter 3, participants put the most (perceived) attractive photographs on the piles of "most liked photographs". With the survey on the role of photographs in interpretive signage (Chapter 6), I found a significant relationship between the perceived attractiveness of the photograph in the signage and participants' attention (i.e. intention to read): signage with a high-quality photograph could attract more visitors to read than the signage without a photograph did, while the sign with a poor-quality photograph of the same subject received an even significantly lower frequency of readings. Regarding the effect of reading signage, my results show that the use of a high-quality photograph significantly increases reading engagement as well as their interests in the relevant topic. Within the context of WeChat Public Account articles, the use of appealing photographs is also closely related to positive emotional responses (i.e. giving thumb-ups after seeing outstanding photographs in a popular science article, for details see Chapter 7).

The findings above show a photograph perceived as appealing can successfully evoke observers' positive emotional responses when integrating such a photograph into science communication materials. It is not surprising that appealing photographs are associated with observers' emotional responses (Silvia 2005). More importantly, such positive emotions such as enjoyment can result in: (i) increased motivation for subsequent, deeper encounters with science (Burns et al. 2003), and (ii) the possibility of longer stays and repeat visitation

(Bramwell & Lane 1993; Munro et al. 2008), which are considered as main management goals for natural areas, including national parks (Kuo 2002).

8.4.2. Cognitive outcomes

Cognitive outcomes are a vital aspect of the effectiveness of interpretation within natural areas (e.g. national parks) (Ham & Weiler 2006). In the field of science communication, such outcomes correspond to the public understanding of science (e.g. scientific discourse, processes and social factors) and their knowledge retention, which is "*a prerequisite for higher levels of scientific literacy and, particularly within the context of science communication, emphasizes applications and implications of science*" (Burns et al. 2003). Given the importance of cognitive responses for science communication, the role of photographs for such cognitive effectiveness was examined carefully within the context of interpretive signage in the selected national park (for details see Chapters 5 and 6).

Results suggest that both participants' understanding of reading and recall of knowledge were positively influenced by the perceived visual appeal of a photograph on signage, where the perceived appeal of such a photograph was determined by its visual quality (Chapter 6). Specifically, in the experiment where I manipulated the interpretive signage that presented information about the Common Kingfisher (Chapter 6), a high-quality (i.e. perceived appealing) photograph of the bird helped participants understand the textual information better than a poor-quality photograph did. The knowledge recall test showed that participants had significantly higher scores from reading the signage with a high-quality photograph than with the other two signs (with a poor-quality photograph and without any photograph). In particular, the influence of photographs is most apparent when the tested knowledge was not only derived from the text but also presented in the photograph (e.g. visual traits of the bird): a total of 23.6% of the participants got two or more correct answers in the knowledge test in the group with an appealing photograph, while this proportion was 9.0% and 2.2% with the signage with a poor photograph and without a photograph, respectively. Significant differences across the manipulated signs suggest that compared to the absence of

photographs (the control group), a poor photograph indeed improved understanding and knowledge retention, while an appealing photograph was much better at these outcomes.

The above findings reveal the significance of appealing photographs for improving tourists' understanding of natural science. An important reason for increasing public understanding of science is that with a higher level of knowledge, individuals are likely to have a more positive attitude towards the relevant scientific topic (e.g. conservation) (Tisdell & Wilson 2004; Glikman et al. 2012). For communicating a number of widely discussed scientific topics, such as climate change, genetic modification and conservation, such public support is considered as a vital aspect (Tisdell & Wilson 2004; McComas et al. 2014; Fletcher 2019). Tisdell and Wilson (2004), for example, examined the relationship between individuals' level of relevant knowledge and their willingness to provide support for conservation of tree-kangaroos. Results showed that the public's willingness to support rose with their knowledge about the species. Accordingly, using photographs with high visual appeal may help to enhance public understanding of science, and thereby promote their willingness to support relevant scientific issues such as conservation and climate change.

8.5. Limitations and potential extensions

The results of this thesis raise some interesting questions that call for further studies. A few limitations of this research are also noted in this section. First, regarding tourists' perceptions of the visual attractiveness of nature photographs (Chapters 3 and 4), specialised bird enthusiasts (SB) showed a significantly different preference for photographs compared to other participants. They focused specifically on photographs of birds rather than the visual qualities across the photographs of different subjects. For this type of participant, the biological or ecological information presented by such a photograph is the most vital factor determining its perceived attractiveness, because most of these SB are bird watchers and they have specific expectations (bird watching and bird watching-related interpretation) when visiting a national park (Maple et al. 2010). Integrating such types of bird photographs (those proven to be effective in Chapters 3 and 4) into interpretive materials and programmes

may make such interpretation more attractive to bird enthusiasts. Further studies are, therefore, needed to clarify this. In addition, when examining the specific influence of visual characteristics of bird photographs on the preferences of SB (Chapter 4), the sample size for bird enthusiasts was too small for the statistical software to calculate the utility and importance of the different visual attributes for this interest group. As a result, the preferences for visual attributes between bird enthusiasts and the other two interest groups could not be systematically compared. One of the reasons for the insufficient number of bird enthusiasts is that even though bird watching is developing rapidly in China, bird watchers are still a small minority of the general public (Ma et al. 2013; Hu et al. 2017), resulting in the difficulty of finding greater numbers of SB for the survey. Accordingly, potential extensions with a larger sample size (or longer period) are suggested to involve more SB and clarify whether they can be attracted by bird photographs with different visual characteristics.

Second, it should be noted that the sample population within the parks were generally young and well educated, which is not reflective of the characteristics of the general public in China (National Bureau of Statistics of China 2017). Similar results of the demographics of national park tourists in China were also found by other researchers: a study in Taibaishan National Forest Park, Shaanxi Province, for example, reported that 30% of the participants were under twenty-five years old and 53% of them aged twenty-five to forty years, while students accounted for 16% of the sample population (He et al. 2005). In parallel, Wu et al. (2004) conducted a survey in the Yushan National Park of Taiwan, Republic of China and found that 43.7% of their sample population was under thirty, while 42.6% of the sample was holding a university degree. However, it is still unclear whether such results reflect the general characteristics of tourists in Chinese national parks.

Another explanation for the young and well-educated participants in this project is that both national parks involved in this study are close to universities or academic institutions (the XNWP and the XRNP, see park descriptions in Chapters 3 and 4), which means a large number of students and university staff/researchers could be found in the study area. Future

studies are, therefore, suggested within more national to ensure sample populations are more representative.

Third, during the survey on the implications of the visual quality photographs for the performance of the manipulated signage (Chapter 6), two photographs with significantly different visual qualities were used in the experiment. Such a design successfully demonstrated the contribution of high-quality photographs to the effectiveness of communication. While in additional research, it would be interesting to introduce more species of birds (even other types of subjects) and examine how these photographs influence the effectiveness of the interpretive signage, because apart from visual quality, the subject of a nature photograph also contributes to its attractiveness: for example, the morphological traits and colouration of the subject (e.g. bird) are important aspects that significantly influences peoples' perception of the appeal of photographs. Additional studies in this area would potentially help to select appropriate species or taxa when designing the interpretive signage about local natural attractions (e.g. biodiversity) within national parks.

Lastly, the effectiveness of science communication includes not only knowledge gain but also behavioural outcomes (Jordan et al. 2011; Fletcher 2019). However, since the study materials in this thesis were introductions of local natural attractions (e.g. birds), I did not find evidence of behavioural impacts based on the manipulation or presentation of photographs. Nevertheless, effective interpretive signage within national parks can indeed enhance tourists' awareness of environmental and biodiversity conservation (Department of Conservation 2005; Ismail 2008). Based on such types of interpretive content, it would be interesting to test whether the visual quality of photographs on an interpretive sign can affect the relevant behavioural outcomes.

8.6. Overall conclusion and implications

For a national park, effective nature interpretation is an important way to enrich tourists' experience, increase their understanding of natural science and/or improve public support

for conservation (Tisdell & Wilson 2004; Department of Conservation 2005; Ham & Weiler 2006; Bickford et al. 2012; Glikman et al. 2012). With regard to interpreting natural attractions within Chinese national parks, this project provides empirical evidence that photography can play a significant role in enhancing interpretation. As shown in Fig. 8.1, tourists' perceived attractiveness of a nature photograph is the most important variable determining whether and to what extent a photograph is effective for interpreting natural science stories within the parks. Within the context of different interpretive products: signage and WeChat, the value of the perceived visual attractiveness of photographs for science communication was examined and confirmed (Fig. 8.1). The findings of this thesis are of global significance because: (i) the lack of human-nature connection is considered as a global issue (Brooks et al. 2006; Groom et al. 2006; Province of Nova Scotia 2008; Giusti et al. 2018), (ii) photography is widely used for both the general public and the science community (Van Dijck 2008; Carr 2012; Aslam 2018), suggesting the potential of developing the use of photography for communicating science, and (iii) as reviewed in Section 2.3.3, both interpretive signage and online platforms are commonly used to interpret natural attractions of national parks throughout the world. Directions for future research are suggested in order to generalise the findings and make the sample population more representative.

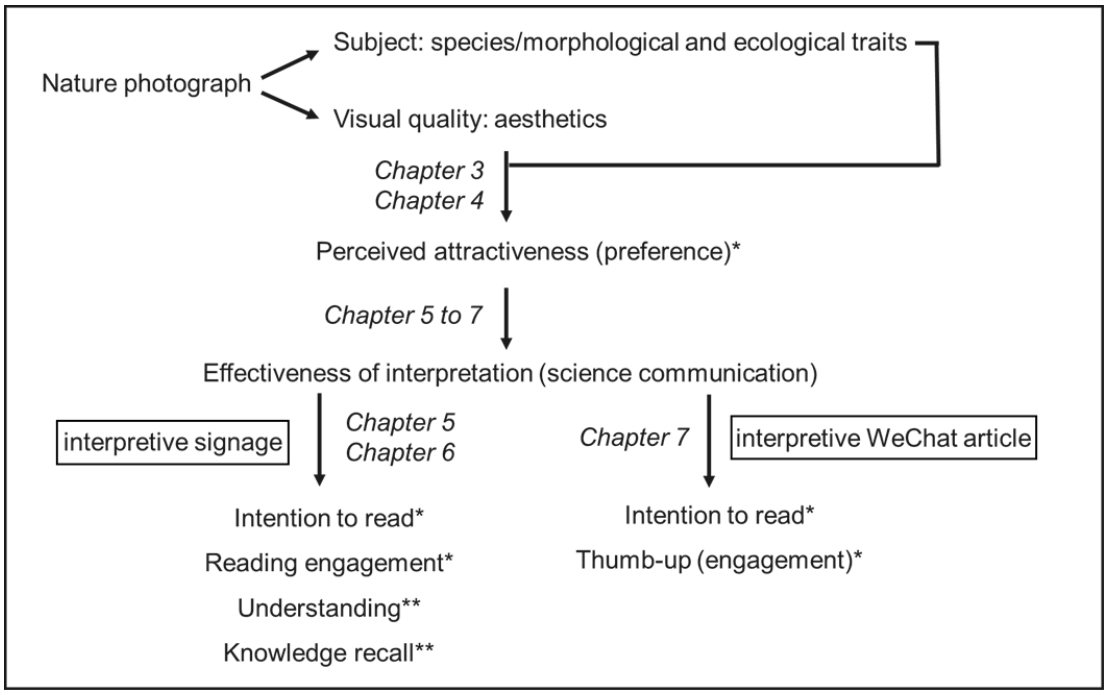


Fig. 8.1 A summary of the findings in this thesis. *Affective outcomes. **Cognitive outcomes.

This thesis has also made methodological contributions. First, given the significant implications that the visual quality of photographs has on participants' preference, the measurement of the visual quality of photographs should be taken into account for further studies. According to the results of this thesis (Chapters 3, 4 and 6), Acquine has proven to be a convenient and helpful application when evaluating the overall visual quality of nature photographs. Second, the results in Chapter 3 and Chapter 4 show that the photograph-based Q method and the CBC analysis are appropriate methods to measure and compare the public's perceptions of the nature photographs of different subjects, visual qualities and manipulated visual elements. Researchers and science communicators are, therefore, encouraged to explore relevant research questions using these methods.

As conservation communication is a cross-disciplinary field, methodologies from other relevant fields (e.g. education, psychology, economy, etc.) should be explored so as to determine more the most effective approaches to enhancing communication of science and nature.

To conclude, this thesis successfully clarified the specific influences of photographs for enhancing the effectiveness of natural science communication through two interpretive products (interpretive signage and WeChat articles). The considerable role that photography can play in science communication is confirmed once again here. More importantly, the findings suggest that not all photographs are equally effective for communication: only those perceived as appealing photographs (e.g. with high visual quality and/or attractive subjects) can motivate individuals to read interpretive materials, evoke positive emotional responses and enhance their understanding and recall of knowledge. This thesis successfully answers the question: what types of photographs are most effective for science communication and why. Photographs, in particular those perceived as appealing ones, will continue to be a significant component of not only national park interpretation, but also science communication throughout the world.

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Appendices

Appendix A – Ethics approval for the field survey (Chapters 3 to 6)

17/061

Academic Services
Manager, Academic Committees, Mr Gary Witte

23 April 2017

Professor L Davis
Centre for Science Communication
133 Union St East

Dear Professor Davis,

I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled "**The use of photography to communicate science in Chinese national parks: a case study in Xixi National Wetland Park**".

As a result of that consideration, the current status of your proposal is:- **Approved**

For your future reference, the Ethics Committee's reference code for this project is:- **17/061**.

The comments and views expressed by the Ethics Committee concerning your proposal are as follows:-

While approving the application, the Committee suggests that you might want to consider abbreviating the Information Sheet and, in this case, the Committee is of the view that a Consent Form is not necessary. Implied consent would be acceptable for the work being proposed.

The Committee also seeks clarification as to whether permission is required to undertake the work in China. Is a research visa required?

Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

The Human Ethics Committee asks for a Final Report to be provided upon completion of the study. The Final Report template can be found on the Human Ethics Web Page

http://www.otago.ac.nz/council/committees/committees/HumanEthicsCommittees.html

Yours sincerely,

Gary Witte

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor L S Davis Director Centre for Science Communication

Academic Services
Manager, Academic Committees, Mr Gary Witte

17/061

7 June 2017

Professor L Davis
Centre for Science Communication
133 Union St East

Dear Professor Davis,

I am again writing to you concerning your proposal entitled "**The use of photography to communicate science in Chinese national parks: a case study in Xixi National Wetland Park**", Ethics Committee reference number **17/061**.

Thank you for your email of 5 June 2017 requesting an amendment to explore the preference of participants for different qualities and types of photographs in relation to Xixi National Wetland Park.

Your proposal continues to be fully approved by the Human Ethics Committee. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing. I hope all goes well for you with your upcoming research.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Professor L S Davis Director Centre for Science Communication

17/061

Academic Services
Manager, Academic Committees, Mr Gary Witte

18 June 2018

Professor L Davis
Centre for Science Communication
133 Union St East

Dear Professor Davis,

I am again writing to you concerning your proposal entitled "**The use of photography to communicate science in Chinese national parks: a case study in Xixi National Wetland Park**", Ethics Committee reference number **17/061**.

Thank you to Lei Zhu, student investigator on the above project, for her email of 15th June 2018 with request for amendment attached. The Committee notes the addition of a new fieldwork site and revised methodology.

The Committee accepts and approves the amendment.

Your proposal continues to be fully approved by the Human Ethics Committee. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing. I hope all goes well for you with your upcoming research.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Assoc. Prof. J M Bering Director Centre for Science Communication

Appendix B – Information sheet for participants: Q method interview in Chapter

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 3: The Use of Photography to Communicate Science in the Xixi National Wetland Park

Information Sheet for Participants

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The topic of the project is to investigate how photographs, in conjunction with interpreting scientific stories within Chinese national parks, can improve science communication. To this end, Xixi national wetland park, as a popular and representative national park in China, has been selected as the study site for field survey. The survey will focus on the preference of participants for different photographs in relation to the Xixi National Wetland Park (XNWP).

What Type of Participants are being Sought?

Participants are recruited within the XNWP: visitors in the XNWP will be invited. Those individuals who had visited the XNWP within six months were also encouraged to participate in the interview. The number of participants will be above thirty for this survey.

What will Participants be Asked to Do?

Should you agree to take part in this project, you will have the thirty photographs and will be asked to sort all the photographs into nine piles according to the question: for these photographs showing natural attractions within the XNWP, what photographs do you like or dislike? The nine piles include different extents of like or dislike. You will spend about twenty minutes completing the questionnaire (including time spent on reading this information sheet). There will not be any discomforts, risks or inconvenience during the participation.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

The thirty to forty Q sorts (based on thirty to forty participants) based on the thirty photographs will be processed in order to undertake the subsequent factor analysis. Data will never be used for commercial purposes.

Interviews will be recorded (audio). However, if you are not happy with being tapped, the interviewer will take notes with a notebook instead of recording.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it: The results will be saved to OneDrive based on Office365.

The physical and online data will be kept for five years. Then they will be destroyed. Only the student researcher (Lei Zhu) and the supervisor (Prof. Lloyd Spencer Davis) will have access to original data.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand), but every attempt will be made to preserve your anonymity.

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Lei Zhu	*Lloyd Spencer Davis*
Centre for Science Communication	Centre for Science Communication
University Telephone Number:	University Telephone Number:
N/A	+64 21 617 176
Email: zhule786@student.otago.ac.nz	Email: lloyd.davis@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research, you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated, and you will be informed of the outcome.

Information sheet for participants, Chapter 3 (Chinese version)

自然影像科学传播效率调查：以西溪国家湿地公园为例

项目信息

亲爱的游客/受访者：

本项目是以西溪国家湿地公园为主题的自然摄影传播效率调研。感谢您对本项目的关注。请在决定是否参与调查之前仔细阅读此项目信息说明。如果您在阅读项目信息后决定参与调查，那么我们将会非常感谢您的参与；如果您决定不参与此项目，您也不会有任何损失或困扰，我们同样感谢您花时间阅读这份项目介绍。

研究目的

本项目旨在探索自然摄影照片视觉特征对其传播效率的影响。西溪国家湿地公园是中国国家公园体系中最早建成的国家湿地公园，其内环境类型和生物多样性丰富多样，故被选为野外调查地点。

什么样的参与者会被邀请受访？

作为西溪国家湿地公园的游客或在近半年内游览过此处的人士，您将被邀请参与调查。受访者的目标数量至少为 30 人。

受访者将会做什么？

访谈流程为：把您面前的三十张照片按“您最喜欢”到“最不喜欢”分成九档，并分别简单解释您最喜欢和最不喜欢的一张照片。您将花费 20 分钟左右来完成这次一对一的访谈（包括阅读项目介绍的时间）。除了时间成本之外，参与本调查不会对您的游览和之后的日常生活产生任何的不便或不良影响。

此外，您有权选择不参与本调查，这项决定同样不会对您的游览和之后的日常生活产生任何的不便或不良影响。

我们如何收集调查数据？数据将如何使用？

调查结果将被用于与研究目的的相关的因子分析和比较。项目数据的唯一来源是您对照片的评价结果，在此过程中不会进行任何与您相关的影像或视频记录。访谈会被全程录音，但是您也可以选择不录音。访谈是匿名的。调查数据不会被用于任何商业用途。

调查结束后，原始数据将会被新西兰奥塔哥大学科学传播学研究中心封存，仅本项目作者（包括博士生作者朱雷和导师劳埃德·斯宾塞·戴维斯教授）有权接触并调阅。基于原始数据汇总的电子文档将会被妥善储存在 Office365 的 OneDrive 中。所有原始数据的封存时间为 5 年，之后它们将会被销毁。

这项研究的成果（论文）将有可能在学术期刊上发表，并可在新西兰奥塔哥大学图书馆下载或调阅。我们将会采取一切可行的措施来保障您（受访者）的隐私。

在您填写完毕调查问卷之后，您将不能修改它们。如果您对研究结果有兴趣，那么可以在项目结题后，联系项目作者调阅研究报告。

受访者是否可以选择退出项目？

在受访（填写问卷和现场交流）期间，您可以随时选择退出，这项决定不会对您的游览和之后的日常生活产生任何的不便或不良影响。

如果您有任何关于本项目的问题？

如果您希望了解关于本项目的更多信息，欢迎联系：

朱雷	劳埃德·斯宾塞·戴维斯教授
奥塔哥大学科学传播学研究中心	奥塔哥大学科学传播学研究中心
工作电话：无	工作电话：+64 21 617 176
电子邮箱：zhule786@student.otago.ac.nz	电子邮箱：lloyd.davis@otago.ac.nz

这项研究已经被新西兰奥塔哥大学学术伦理委员会（University of Otago Human Ethics Committee）批准。如果您有任何涉及本项目学术伦理规则的疑问，欢迎联系奥塔哥大学学术伦理委员会（电话：+64 3 479 8256，或电子邮箱：gary.witte@otago.ac.nz）。您提出的任何问题都将会被严格保密并仔细调查，并将及时通知您调查结果。

Appendix C – Consent form: Q method interview in Chapter 3

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 3: the use of photography to communicate science in the Xixi National Wetland Park

Consent Form for Participants

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. Personal identifying information [*audio recordings*] may be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project.

....

(Signature of participant) (Date)

..... (Printed Name)

Name of person taking consent .....

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Consent form, Chapter 3 (Chinese version)

[批准文号]
[日期]

自然影像科学传播效率调查：以西溪国家湿地公园为例

受访者知情同意书

作为受访者，我已经认真阅读并了解了项目基本信息。在调查问卷中，我回答的所有问题都是基于我个人经验得出的判断和评价。我了解我可以在项目的任何阶段联系作者获取必要的相关信息。

我了解：

1. 我自愿决定参与本项目的调查及访谈；
2. 我可以在受访期间的任何时候选择退出，并且这项决定不会对我的游览和之后的日常生活产生任何的不便或不良影响；
3. 项目负责人将会对本项目进行录音，本项目的原始数据将会保存五年，之后会被销毁；
4. 这项研究的成果（论文）将有可能在学术期刊上发表，并可在新西兰奥塔哥大学图书馆下载或调阅。项目负责人和奥塔哥大学将会采取一切可行的措施来保障我的隐私。

我同意参与这项调查。

....

(受访者签名) (日期)

.....

(正楷姓名)

.....

(项目负责人签名)

这项研究已经被新西兰奥塔哥大学学术伦理委员会（University of Otago Human Ethics Committee）批准。如果您有任何涉及本项目学术伦理规则的疑问，欢迎联系奥塔哥大学术伦理委员会（电话：643 479 8256，或电子邮箱：gary.witte@otago.ac.nz）。您提出的任何问题都将会被严格保密并仔细调查，并将及时通知您调查结果。

Appendix D – Licensing agreements on the photographs involved in Chapter 3

The detail of the Creative Common License see https://creativecommons.org/licenses/.

ID	The subject of the selected photograph	Attribute	Link	License
WV01	Pond with wetland vegetation	Lei Zhu (own work)	N/A	N/A
WV04	Pond with wetland vegetation	Lei Zhu (own work)	N/A	N/A
WV03	Pond with wetland vegetation	Lei Zhu (own work)	N/A	N/A
RT02	Wetland, forests and bridge	Lei Zhu (own work)	N/A	N/A
RT01	Wetland, reed and bridge	Lei Zhu (own work)	N/A	N/A
CK03	Small wetland bird – Common Kingfisher	Martha de Jong-Lantink	goo.gl/KpYSif	CC BY-NC-ND 2.0
CK01	Small wetland bird – Common Kingfisher	Melvin Yap	goo.gl/SrzjKc	CC BY-NC-ND 2.0
CK06	Small wetland bird – Common Kingfisher	Charles Lam	goo.gl/ZlNvbT	CC BY-SA 2.0
MD05	Intermediate wetland bird –Mandarin Duck	Frank Vassen	goo.gl/1E6OrZ	CC BY 2.0
MD01	Intermediate wetland bird –Mandarin Duck	Lei Zhu (own work)	N/A	N/A
MD03	Intermediate wetland bird –Mandarin Duck	Lei Zhu (own work)	N/A	N/A
LE01	Large wetland bird – Little Egret	Victor	goo.gl/swZS5c	CC BY-NC-ND 2.0
LE06	Large wetland bird – Little Egret	Lei Zhu (own work)	N/A	N/A
LE02	Large wetland bird – Little Egret	Lei Zhu (own work)	N/A	N/A
VP03	Small passerine –Vinous-throated Parrotbill	Lei Zhu (own work)	N/A	N/A
VP01	Small passerine –Vinous-throated Parrotbill	Lei Zhu (own work)	N/A	N/A
VP02	Small passerine –Vinous-throated Parrotbill	Lei Zhu (own work)	N/A	N/A
LB01	Intermediate passerine –Light-vented Bulbul	Lei Zhu (own work)	N/A	N/A
LB04	Intermediate passerine –Light-vented Bulbul	Lei Zhu (own work)	N/A	N/A
LB06	Intermediate passerine –Light-vented Bulbul	Lei Zhu (own work)	N/A	N/A
RM06	Large passerine – Red-billed Blue Magpie	Sameer Karmarkar	goo.gl/ETOvyQ	CC BY-NC 2.0
RM02	Large passerine – Red-billed Blue Magpie	Lei Zhu (own work)	N/A	N/A
RM04	Large passerine – Red-billed Blue Magpie	Lei Zhu (own work)	N/A	N/A
RG01	Black-spotted Frog	Lei Zhu (own work)	N/A	N/A
PZ01	Globe Skimmer Dragonfly	S. H.	goo.gl/ovfGaC	CC BY-ND 2.0
FR01	Forest (wide angle)	Lei Zhu (own work)	N/A	N/A
FR02	One tree in the forest	Lei Zhu (own work)	N/A	N/A
BS01	Shrub (close-up shot)	Lei Zhu (own work)	N/A	N/A
HD01	A bird-watching hide	Lei Zhu (own work)	N/A	N/A
SN01	A bird information board (Interpretive sign)	Lei Zhu (own work)	N/A	N/A

Appendix E – Participants' explanations of their choices for Factor 1 of the Q method interview (Chapter 3)

In Chapter 3, the participants were asked to give explanations of their preferred or disliked photographs. Here, such explanations given by the participants who were loaded on Factor 1 (Wildlife Photographs with Outstanding Aesthetic Value) were presented because: (i) these explanations show how the participants evaluated these photographs based on the visual quality (aesthetics) of them, and (ii) they give an idea of the role of some important visual aesthetic attributes (e.g. sharpness, colouration), which was further examined in Chapter 4.

The six highly commended photographs of Factor 1, corresponding to Table 3-4.

Photograph MD05: Mandarin Duck (Q score = +4).

Fig. 10.1 Photograph MD05, By Frank Vassen, from goo.gl/1E6OrZ, CC BY 2.0.

Participant 13: "The combination of the feather colour is comfortable, also in harmony with the water (colour)."

Participant 12: “I like Mandarin ducks. They are beautiful. This is also one of the only few birds I knew.”

Participant 9: “As a birdwatcher, I like the emotion expressed by the photo: The bird looks sleepy and relax. It is telling a simple but good story.”

Participant 1: “The Mandarin duck is locally common. This photograph is stunning and under comfortable light condition.”

Participant 22: “The combination of colours of this animal impressed me.”

Participant 26: “The bird is just beautiful.”

Participant 30: “A good atmosphere can be reflected in this photograph. I like the colouration and exposure of this photograph.”

Participant 32: “I like this bird. Its feather colours look comfortable.”

Participant 35: “This photograph is sharp and colourful, in a comfortable way. This is why I like it.”

Participant 36: “Good light condition, but the most important thing is the accurate exposure and amazing colouration.”

Photograph CK03: Common Kingfisher (Q score = +3)

Fig. 10.2 Photograph CK03. By Martha de Jong-Lantink, from goo.gl/KpYSif, CC BY-NC-ND 2.0.

Participant 13: “It is the best photograph here – clear and sharp, and with good behaviour. Look at its behaviour! The kingfisher is eating a fish! How interesting!”

Participant 9: “This is an amazing capture of a hunting kingfisher. Such a moment is very rare and very difficult to capture.”

Participant 6: “This photograph includes both the kingfisher and the fish, reflecting a good moment in wetlands. Also, kingfishers are the most colourful water birds. So, this is my favourite photograph.”

Participant 21: “The bird in the photograph is sharp. I can even see the detail of each feather! It is also telling a story about hunting for fish. Actually, it is not only a story but also a science popularisation procedure, because I did not know kingfishers eat fish as food before seeing this photograph.”

Participant 26: “The little bird is eating a fish! How amazing! How did it catch it? I can never catch fish by myself.”

Participant 30: “The bird is colourful and shiny. I like colours like this.”

Participant 34: “First of all, the primary subject is sharp. Secondly, with such a dark background, it is difficult to get the correct exposure, but this photographer did it! Thirdly, I also noticed the fish caught by the bird. It created an imaginative space beyond the photograph itself.”

Photograph CK01: Common Kingfisher (Q score = +3)

Fig. 10.3 Photograph CK01. By Melvin Yap, from goo.gl/SrzjKc, CC BY-NC-ND 2.0.

Participant 12: “I like this photograph because it shows the colourful feathers of the bird perfectly.”

Participant 6: “The bird in the photograph is clear and noticeable. I also noticed the water in the background, and then I can imagine the local (wetland) habitat.”

Participant 1: “It must be the most beautiful bird among them. Obviously, the photographer is skilled, with not only the bird but also the environment (water) being captured. In summary, it is an outstanding photograph both from photographic and ecological perspectives.”

Participant 1: “This is a side view bird, so I am able to see all its stunning blue, green and orange feathers on its back, wings and belly. How beautiful it is!”

Participant 32: “The photograph is just fine from the photographic perspective: clear, colourful, correct exposure, also not a bad composition, but I did not see any eye-catching elements in this photograph. Nevertheless, I can acquire some ecological information from the photograph, such as the habitat (water) of this beautiful bird.”

Photograph RM06: Red-billed Blue Magpie (Q score = +2)

Fig. 10.4 Photograph RM06. By Sameer Karmarkar, from goo.gl/ETOvyQ, CC BY-NC 2.0.

Participant 13: “I do not know the name of this bird, but I have seen it nearby. The bird in the photograph is clear and with colourful feathers. I like its extremely long tail (feathers) most – very special and attractive!”

Participant 1: “I like birds with a long tail (feathers). The photograph is clear, and the colouration and the light condition are comfortable. The bird is looking backwards (what is it looking at?), which is very interesting and looks like there is something in that direction.”

Photograph LB04: Light-vented Bulbul (Q score = +2)

Fig. 10.5 Photograph LB04. Own work.

No comment available

Photograph PZ01: Globe Skimmer Dragonfly (Q score = +2)

Fig. 10.6 Photograph PZ01. By S. H., from goo.gl/ovfGaC, CC BY-ND 2.0.

Participant 12: “I like the colours of this photograph. Also, the subject (i.e. the dragonfly) in the photograph is eye-catching.”

Participant 9: “The dragonfly is clear and sharp. I do not know the exact species, but it looks like it is the moment before something happening – I can imagine a lot through this photograph.”

Participant 22: “This dragonfly is special, in a good way. Most of them are red-brown or grey, but this one is black and white – so stunning!”

Participant 30: “I like this photograph because the dragonfly is successfully isolated from the background, which made me focus on it. In addition, it is not easy to get the correct exposure on black-and-white elements like this (dragonfly), meaning the photographer is experienced.”

Participant 34: “I just like the colours of both the dragonfly and the background. These colours are harmonious and comfortable.”

The six disliked photographs of Factor 1, corresponding to Table 3.5.

Photograph VP02: Vinous-throated Parrotbill (Q score = -4)

Fig. 10.7 Photograph VP02. Own work.

Participant 13: “The bird itself looks not beautiful at all. Its feather colour is similar to the background (reeds). As a result, the bird is not attractive.”

Participant 12: “The background is a mess! And the composition is not comfortable. The bird is not beautiful.”

Participant 1: “The bird in this photograph is not beautiful. I do not like the colour of it. The biggest problem is blurry.”

Participant 26: “I just do not like the colour of both the bird and the background.”

Participant 30: “First of all, this bird looks too ordinary. Also, from a photographic perspective, it is not a good photograph at all: The bird is blurry and blocked by the foreground. The photographer needs not only a better lens but also better skills.”

Participant 34: “Blurry bird.”

Participant 36: “The bird itself is not colourful at all. The photographer needs to carefully think about how to take an eye-catching photograph for it. Unfortunately, this is not a successful photograph as the background is too complicated, and the colour is almost the same as the colour of the bird.”

Photograph LB06: Light-vented Bulbul (Q score = -4)

Fig. 10.8 Photograph LB06. Own work.

Participant 9: “The photograph is slightly over-exposed. The bird is partly blocked by the shrub, resulting in the lack of some key information for species identification and the problem on composition. The bird is not very sharp as the focus is on the branch.”

Participant 6: “Both the foreground and background are complicated. So I cannot focus on the bird at first.”

Participant 22: “The bird and the background look ordinary. It can be everywhere.”

Participant 26: “The background looks colourful with red fruits as well as the green leaves, and even more colourful than the bird. I do not even know the main subject is the bird or the shrub in the background.”

Participant 30: “I do not like this photograph just because the bird looks poor, not beautiful at all.”

Photograph CK06: Common kingfisher (Q score = -3)

Fig. 10.9 Photograph CK06. By Charles Lam, from goo.gl/ZlNvbT, CC BY-SA 2.0.

Participant 13: “It is too blurry.”

Participant 12: “I feel uncomfortable after seeing this photograph: too blurry. I know there are a variety of criteria for evaluating photographs and just focusing on the clarity is unfair. But this one is too blurry that destroyed everything.”

Participant 9: “It is too blurry! For nature photography, sharpness is very important in most circumstances.”

Participant 6: “Blurry bird, stupid background, no imaginative space.”

Participant 1: “It is too blurry that I do not know what it wants to express, and I cannot see any beautiful elements and useful information from this photograph.”

Participant 21: “This photograph is blurry, not clear at all. No one likes a photograph such as this.”

Participant 26: “The kingfisher is blurry, extremely blurry!”

Participant 32: “This photograph is too blurry that I can hardly recognise the bird.”

Participant 34: “It is an amazingly blurry photograph. Such a beautiful bird was captured by such a terrible photographer, what a shame!”

Photograph SN01: An interpretive sign about local birdwatching (Q score = -2)

Fig. 10.10 Photograph SN01. Own work.

Participant 13: “Such an interpretive sign is important in a national park, but this sign is really not appealing at all: long paragraphs of text in very small font size and a poor photograph (on the sign).”

Participant 6: “I have seen this sign in the park but did not want to read it at all. I do not like the signage with a lot of words, because I feel under pressure when reading it. Also, the photograph on the sign is not an outstanding one. It is easy to get an excellent photograph of such an abundant egret, but this one is indeed just a bit better than poor.”

Participant 32: “It says a lot, but I do not want to read.”

Photograph WV03: Wetland vegetation (Q score = -2)

Fig. 10.11 Photograph WV03. Own work.

Participant 12: “It is a bit blurry and over-exposure. Also, I do not know what (information or emotion) it is expressing.”

Participant 1: “For me, photographs of landscapes and environments (mainly vegetation) are not as attractive as wildlife photographs. Secondly, it is blurry and has problems with exposure.”

Participant 30: “I know the photographer wanted to photograph the local vegetation. However, no one will be attracted and willing to visit the park if they see such a blurry photograph.”

Participant 32: “It is blurry.”

Participant 34: “It is not only blurry but also over-exposure.”

Participant 35: “I did not find a clear subject in this photograph. What was this photographer shooting for? In addition, green is normally a pleasant colour, but in this photograph, the colouration is uncomfortable.”

Photograph RM04: Red-billed Blue Magpie (Q score = -2)

Fig. 10.12 Photograph RM04. Own work.

Participant 35: “The light condition is good. But some technical aspects, such as the exposure of this photograph, made me uncomfortable.”

Participant 36: “The photograph is obviously over-exposure. The bird looks stunning, but I just do not like this photograph.”

Appendix F – Information sheet for participants: the CBC analysis on manipulated photographs in Chapter 4

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 4: Visual Elements of Wildlife Photographs that Engage Tourists within the Xishuangbanna Rainforest National Park

Information Sheet for Participants

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate, we thank you. If you decide not to take part there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The topic of the project is to confirm and clarify how visual attributes wildlife of photographs influence their attractiveness, then affect the efficiency of the signs to communicate science.

What Type of Participants are being Sought?

The number of participants (tourists) should be above 120 and as many as possible. The suggested sample size is about 300.

What will Participants be Asked to Do?

These are photographs of different local birds in the XRNP, amongst the four photographs on each card, which photograph is the most attractive to you? Or none of them? You will then start to make twenty choices from Card 1 to Card 20 (five alternatives on each card). The survey will take approximately thirty minutes. You can get a postcard set with four postcards (NZ wildlife) as a gift after completing the survey. There will not be any discomforts, risks or inconvenience during the participation.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

You will be asked to choose no more than one favourite profile on each card. Also, since your demographic information and interests in birds are also likely to influence the preference, such information will also be collected during the field survey. Data will never be used for commercial purposes.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it: The results will be saved to OneDrive based on Office365. The physical and online data will be kept for five years. Then they will be destroyed. Only the student researcher (Lei Zhu) and the supervisor (Prof. Lloyd Spencer Davis) will have access to original data. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand), but every attempt will be made to preserve your anonymity.

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Lei Zhu

Centre for Science Communication

University Telephone Number:

N/A

Email: zhule786@student.otago.ac.nz

Lloyd Spencer Davis

Centre for Science Communication

University Telephone Number:

+64 21 617 176

Email: lloyd.davis@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Information sheet for participants, Chapter 4 (Chinese version)

自然影像科学传播效率调查：以西双版纳热带雨林国家森林公园为例

项目信息

亲爱的游客/受访者：

本项目是西双版纳本地鸟类为主题的自然摄影传播效率调研。感谢您对本项目的关注。请在决定是否参与调查之前仔细阅读此项目信息说明。如果您在阅读项目信息后决定参与调查，那么我们将会非常感谢您的参与；如果您决定不参与此项目，您也不会有任何损失或困扰，我们同样感谢您花时间阅读这份项目介绍。

研究目的

本项目的研究目的为探索不同类型和美学价值的照片的传播效率。

什么样的参与者会被邀请受访？

作为西双版纳热带植物园的游客，您将被邀请参与调查。受访者的目标数量为 300 人左右。

受访者将会做什么？

访谈流程为：您首先填写一调查人口统计学信息的短问卷（包括性别、年龄段、教育程度和对鸟类兴趣等）。接下来，您将从一系列本地鸟类照片中根据您的个人喜好进行比较和选择。您有权选择“一个都不喜欢”之选项。调查时间为 30 分钟。除了时间成本之外，参与本调查不会对您的游览和之后的日常生活产生任何的不便或不良影响。

此外，您有权选择不参与本调查，这项决定同样不会对您的游览和之后的日常生活产生任何的不便或不良影响。

我们如何收集调查数据？数据将如何使用？

调查结果将被用于与研究目的的相关的分析和比较。项目数据的唯一来源是您对照片的评价结果，在此过程中不会进行任何与您相关的影像、视频和声音记录。访谈是匿名的。调查数据不会被用于任何商业用途。

调查结束后，原始数据将会被新西兰奥塔哥大学科学传播学研究中心封存，仅本项目作者（包括博士生作者朱雷和导师劳埃德·斯宾塞·戴维斯教授）有权接触并调阅。基于原始数据汇总的电子文档将会被妥善储存在 Office365 的 OneDrive 中。所有原始数据的封存时间为 5 年，之后它们将会被销毁。

这项研究的成果（论文）将有可能在学术期刊上发表，并可在新西兰奥塔哥大学图书馆下载或调阅。我们将会采取一切可行的措施来保障您（受访者）的隐私。

在您完成调查问卷及照片选择后，您将不能修改这些结果。如果您对研究结果有兴趣，那么可以在项目结题后，联系项目作者调阅研究报告。

受访者是否可以选择退出项目？

在受访期间，您可以随时选择退出受访，这项决定不会对您的游览和之后的日常生活产生任何的不便或不良影响。

如果您有任何关于本项目的问题？

如果您希望了解关于本项目的更多信息，欢迎联系：

朱雷	劳埃德·斯宾塞·戴维斯教授
奥塔哥大学科学传播学研究中心	奥塔哥大学科学传播学研究中心
工作电话：无	工作电话：+64 21 617 176
电子邮箱：zhule786@student.otago.ac.nz	电子邮箱：lloyd.davis@otago.ac.nz

这项研究已经被新西兰奥塔哥大学学术伦理委员会（University of Otago Human Ethics Committee）批准。如果您有任何涉及本项目学术伦理规则的疑问，欢迎联系奥塔哥大学学术伦理委员会（电话：+64 3 479 8256，或电子邮箱：gary.witte@otago.ac.nz）。您提出的任何问题都将会被严格保密并仔细调查，并将及时通知您调查结果。

Appendix G – Information sheet for participants: the survey on the performance of the existing interpretive signage within the XNWP (Chapter 5)

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 5: The Effectiveness of the Existing Interpretive Signage within the Xixi National Wetland Park

Information Sheet for Participants

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate, we thank you. If you decide not to take part there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The topic of the project is to investigate how photographs, in conjunction with interpreting scientific stories in Chinese national parks, can improve science communication. To this end, Xixi national wetland park, as a popular and representative national park in China, has been selected as the study site for field survey. The survey will focus on the use and effectiveness of photographs for interpreting scientific stories on signs within Xixi national wetland park.

What Type of Participants are being Sought?

Participants are recruited within Xixi national wetland park: visitors in Xixi national wetland park will be invited to fill out the questionnaire.

What will Participants be Asked to Do?

Should you agree to take part in this project, you will be asked to fill out a questionnaire which is about the characteristics (i.e. general impressions and attractiveness) of the existing interpretive signs within the park, as well as your opinions in terms of interpretive signs in Chines national parks. You will spend about five minutes completing the questionnaire (including time spent on reading this information sheet). There will not be any discomforts, risks or inconvenience during the participation.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

The expected number of participants is 300 (minimum). You will not be audio or video recorded. Your personal information will not be collected. Data will be used to analyse the efficiency of signs for popularising scientific matters within the national park. Data will never be used for commercial purposes.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it: Completed physical answer sheets and consent forms for field questionnaires will be stored in a locked cabinet in a locked room in the centre for science communication, University of Otago. The transcribed data based on the field questionnaires will be saved to OneDrive based on Office365. The physical and online data

will be kept for five years. Then they will be destroyed. Only the student researcher (Lei Zhu) and the supervisor (Prof. Lloyd Spencer Davis) will have access to original data.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand), but every attempt will be made to preserve your anonymity.

Participants will not be given access to the data in its raw format. The results of the research will be available to participants when the project has been completed.

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Lei Zhu
Centre for Science Communication
University Telephone Number:
N/A
Email: zhule786@student.otago.ac.nz

Lloyd Spencer Davis
Centre for Science Communication
University Telephone Number:
+64 21 617 176
Email: lloyd.davis@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Information sheet for participants, Chapter 5 (Chinese version)

西溪国家湿地公园科普信息板传播效率调查

项目信息

亲爱的游客/受访者：

本项目是关于西溪国家湿地公园内科普信息板传播效率的调研。感谢您对本次调查的关注。请在决定是否参与调查（填写问卷）之前仔细阅读此项目信息说明。如果您在阅读项目信息后决定参与调查，那么我们将会非常感谢您的参与；如果您决定不参与此项目，您也不会有任何损失或困扰，我们同样感谢您花时间阅读这份项目介绍。

研究目的

科普信息板是被全世界绝大多数国家公园广泛使用的一种科普信息平台，西溪国家湿地公园是中国国家公园体系中最早建成的国家湿地公园，其内同样也有不少这种形式的科普信息板或信息牌，为游客了解公园的环境和野生动植物提供了便捷的渠道。本项目的研究目的是调研西溪国家湿地公园内现有科普信息板（包括其上的图片和文字）的科学传播效率。

什么样的参与者会被邀请受访？

作为西溪国家湿地公园的游客，您将被邀请参与调查。

受访者将会做什么？

如果您同意参与本项目，您将填写一份关于西溪国家湿地公园现有科普信息板的调查问卷，问卷内容主要为您对西溪国家湿地公园内现有科普信息板的总体印象和评价。您将花费五分钟左右来填写这份问卷（包括阅读项目介绍的时间）。除了时间成本之外，参与本调查不会对您的游览和之后的日常生活产生任何的不便或不良影响。

此外，您有权选择不参与本调查，这项决定同样不会对您的游览和之后的日常生活产生任何的不便或不良影响。

我们如何收集调查数据？数据将如何使用？

本项目的目标样本量为约 300 份有效的调查问卷，调查结果将被用于与研究目的的相关的总结和比较。项目数据的唯一来源是您填写的调查问卷，在此过程中不会进行任何与您相关的影像或视频记录。所有的调查问卷都是匿名的。因此，在填写调查问卷时，您无需填写个人信息。调查数据不会被用于任何商业用途。

调查结束后，原始数据（您填写的调查问卷）将会被新西兰奥塔哥大学科学传播学研究中心封存，仅本项目作者（包括博士生作者朱雷和导师劳埃德·斯宾塞·戴维斯教授）有权接触并调阅。基于原始数据汇总的电子文档将会被妥善储存在 Office365 的 OneDrive 中。所有原始数据的封存时间为 5 年，之后它们将会被销毁。这项研究的成果（论文）将有可能在学术期刊上发表，并可在新西兰奥塔哥大学图书馆下载或调阅。我们将会采取一切可行的措施来保障您（受访者）的隐私。

在您填写完毕调查问卷之后，您将不能修改它们。如果您对研究结果有兴趣，那么可以在项目结题后，联系项目作者调阅研究报告。

受访者是否可以选择退出项目？

在受访（填写问卷）期间，您可以随时选择退出，这项决定不会对您的游览和之后的日常生活产生任何的不便或不良影响。

如果您有任何关于本项目的问题？

如果您希望了解关于本项目的更多信息，欢迎联系：

朱雷	劳埃德·斯宾塞·戴维斯教授
奥塔哥大学科学传播学研究中心	奥塔哥大学科学传播学研究中心
工作电话：无	工作电话：+64 21 617 176
电子邮箱：zhule786@student.otago.ac.nz	电子邮箱：lloyd.davis@otago.ac.nz

这项研究已经被新西兰奥塔哥大学学术伦理委员会（University of Otago Human Ethics Committee）批准。如果您有任何涉及本项目道德规则的疑问，欢迎联系奥塔哥大学学术伦理委员会（电话：+64 3 479 8256，或电子邮箱：gary.witte@otago.ac.nz）。您提出的任何问题都将会被严格保密并仔细调查，并将及时通知您调查结果。

Appendix H – The questionnaire for the survey on the performance of the existing interpretive signage within the XNWP (Chapter 5)

Section A: Demographic and background information	
Your age	□ 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55 or over □ I would rather not say
Your gender	□ Male □ Female □ Other □ I would rather not say
Your highest education level	□ High school or lower level □ Graduate Diploma □ Bachelor □ Master □ Ph.D. □ I would rather not say
Interest in birds	□ I am interested in birds and have specific knowledge of birds. (bird enthusiasts, bird watchers or biologists/conservationist, including students of the relevant majors). □ I am generally interested in birds, but do not have much experience and specific knowledge of birds (i.e. identification/habits/ecology/conservation, etc.). □ I am not interested in birds.

Section B: Questions based on the existing signage within the park					
Item	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Agree	Strongly Disagree
I always look for interpretive signs intentionally when visiting a national park like the XNWP.					
A good photograph on the sign always attracts me to read the information there.					
Interpretive signs about local natural attractions are necessary for a national park such as the XNWP.					
The interpretive signs in the XNWP are easy to find.					
The interpretive signs within this park are located in the birdwatching hide of Lianhuatan bird watching area. I have read most of these signs.					
I feel better informed by reading the signage within the XNWP.					
Generally, the photographs on interpretive signs in the XNWP are appealing.					
Generally, I enjoy reading the interpretive signs within the XNWP.					
Generally, the images on signs can help me understand the text information better.					

I will still remember most of the scientific facts on the signs after going back home.					
I will share the scientific stories/facts I learned from the signs with friends/family.					

Questionnaire, Chapter 5 (Chinese version)

第一部分：背景信息	
您的年龄？	☐ 18-24 岁 ☐ 25-34 岁 ☐ 35-44 岁 ☐ 45-54 岁 ☐ 55 岁或以上 ☐ 我不想透露我的年龄段
您的性别？	☐ 男 ☐ 女 ☐ 其他 ☐ 我不希望透露
您的受教育程度？	☐ 高中或高中以下 ☐ 大学专科 ☐ 大学本科 ☐ 硕士 ☐ 博士 ☐ 我不希望透露
您对鸟类的兴趣	□ 我对鸟有兴趣，并且有一定的知识储备和相关经验（如观鸟爱好者、鸟类学工作者或相关专业的学生/从业者） □ 我对鸟有兴趣，但并没有什么相关的知识储备和经验 □ 我对鸟没有什么兴趣

第二部分：基于西溪国家湿地公园内现有科普解说牌的问题

项目	完全同意	基本同意	不一定/ 不确定	不太同意	完全 不同意
当参观一个国家公园时，我会主动寻找、阅读相关的科普解说牌					
通常而言，我选择阅读科普解说牌是因为其上精美的配图吸引了我					
对于国家公园（如西溪国家湿地公园）而言，科普解说牌是非常必要的					
西溪国家湿地公园内的科普解说牌很好找，能让游客接触到足够的科学信息					
今次（或往次）游览时，我已阅读了西溪国家湿地公园内的大部分科普解说牌					
总体而言，西溪国家湿地公园内的科普解说牌内容让我增长了知识					
总体而言，西溪国家湿地公园内的科普解说牌的上的照片很有吸引力					
我很享受阅读这些科普解说牌的过程					
西溪国家湿地公园内科普解说牌的配图能帮我更好地理解文字信息					
当我从西溪国家湿地公园返回后，我仍然能记得科普解说牌上的大部分内容					
我会把从西溪国家湿地公园内科普解说牌上学到的知识分享给我的朋友、家人					

Appendix I – Information sheet for participants: the value of photographs for manipulated interpretive signage within the XNWP (Chapter 6)

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 6: The Use of Photography to Communicate Science in the Xixi National Wetland Park (Manipulated Signage)

Information Sheet for Participants

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate, we thank you. If you decide not to take part there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

The aim of the project is to investigate how photographs, in conjunction with interpreting scientific stories in Chinese national parks, can improve science communication. To this end, the Xixi National Wetland Park (XNWP), as a popular and representative national park in China, has been selected as the study site for field survey. The survey will focus on the use and effectiveness of photographs for interpreting scientific stories on the existing signage within this park.

What Type of Participants are being Sought?

Participants are recruited within the XNWP: visitors will be invited to fill out the questionnaire.

What will Participants be Asked to Do?

Should you agree to take part in this project, you will be asked to read the information on the temporary sign first, and then fill out a questionnaire about the effectiveness of that sign for science communication. You will spend about one minute on reading the sign, and five minutes on completing the questionnaire (including time spent on reading this information sheet). When filling out the questionnaire, please do not watch or read the sign again to ensure the effect of the questions. There will not be any discomforts, risks or inconvenience during the participation.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

A total of 1,000 to 1,500 questionnaires will be done during the three weeks. You will not be audio or video recorded. Your personal information will not be collected. Data will be used to analyse the efficiency of signs for popularising scientific matters within the national park. Data will never be used for commercial purposes.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it: Completed physical answer sheets and consent forms for field questionnaires will be stored in a locked cabinet in a locked room in the centre for science communication, University of Otago. The transcribed data based on the field questionnaires will be saved to OneDrive based on Office365. The physical and online data

will be kept for five years. Then they will be destroyed. Only the student researcher (Lei Zhu) and the supervisor (Prof. Lloyd Spencer Davis) will have access to original data.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

Participants will not be given access to the data in its raw format. The results of the research will be available to participants when the project has been completed.

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Lei Zhu
Centre for Science Communication
University Telephone Number:
N/A
Email: zhule786@student.otago.ac.nz

Lloyd Spencer Davis
Centre for Science Communication
University Telephone Number:
+64 21 617 176
Email: lloyd.davis@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Information sheet for participants, Chapter 6 (Chinese version)

基于不同图文设计的科普信息板传播效果调查

项目信息

亲爱的游客/受访者：

本项目是关于不同图文设计的科普信息板传播效率的调研，调研地点在西溪国家湿地公园。感谢您对本次调查的关注。请在决定是否参与调查（填写问卷）之前仔细阅读此项目信息说明。如果您在阅读项目信息后决定参与调查，那么我们将会非常感谢您的参与；如果您决定不参与此项目，您也不会有任何损失或困扰，我们同样感谢您花时间阅读这份项目介绍。

研究目的

科普信息板是被全世界绝大多数国家公园广泛使用的一种科普信息平台，西溪国家湿地公园是中国国家公园体系中最早建成的国家湿地公园，其内同样也有不少这种形式的科普信息板或信息牌，为游客了解公园的环境和野生动植物提供了便捷的渠道。本项目的研究目的是调研、比较不同图文设计形式的科普信息板的科学传播效率。

什么样的参与者会被邀请受访？

作为西溪国家湿地公园的游客，您将被邀请参与调查。

受访者将会做什么？

如果您同意参与本项目，您将填写一份基于某种图文设计的科普信息板科学传播效率的调查问卷，问卷内容主要为您对中国国家公园内科普信息板的总体印象和评价，以及您对这块科普信息板所述科学信息的阅读感受与评价。您将首先花费一分钟左右来阅读这块科普信息板，之后花费三到五分钟填写这份问卷。除了时间成本之外，参与本调查不会对您的游览和之后的日常生活产生任何的不便或不良影响。此外，您有权选择不参与本调查，这项决定同样不会对您的游览和之后的日常生活产生任何的不便或不良影响。

我们如何收集调查数据？数据将如何使用？

本项目的目标样本量为 1000 到 1500 份有效的调查问卷，这些数据将被用于与研究目的的相关的总结和比较。项目数据的唯一来源是您填写的调查问卷，在此过程中不会进行任何与您相关的影像或视频记录。所有的调查问卷都是匿名的。因此，在填写调查问卷时，您无需填写个人身份信息。调查数据不会被用于任何商业用途。

调查结束后，原始数据将会被新西兰奥塔哥大学科学传播学研究中心封存，仅本项目作者（包括博士生作者朱雷和导师劳埃德·斯宾塞·戴维斯教授）有权接触并调阅。基于原始数据汇总的电子文档将会被妥善储存在 Office365 的 OneDrive 中。所有原始数据的封存时间为 5 年，之后它们将会被销毁。这项研究的成果（论文）将有可能在学术期刊上发表，并可在新西兰奥塔哥大学图书馆下载或调阅。我们将会采取一切可行的措施来保障您（受访者）的隐私。

在您填写完毕调查问卷之后，您将不能修改它们。如果您对研究结果有兴趣，那么可以在项目结题后，联系项目作者调阅研究报告。

受访者是否可以选择退出项目？

在受访（填写问卷）期间，您可以随时选择退出受访，这项决定不会对您的游览和之后的日常生活产生任何的不便或不良影响。

如果您有任何关于本项目的问题？

如果您希望了解关于本项目的更多信息，欢迎联系：

朱雷	劳埃德·斯宾塞·戴维斯教授
奥塔哥大学科学传播学研究中心	奥塔哥大学科学传播学研究中心
工作电话：无	工作电话：+64 21 617 176
电子邮箱：zhule786@student.otago.ac.nz	电子邮箱：lloyd.davis@otago.ac.nz

这项研究已经被新西兰奥塔哥大学学术伦理委员会（University of Otago Human Ethics Committee）批准。如果您有任何涉及本项目学术伦理的疑问，欢迎联系奥塔哥大学学术伦理委员会（电话：+64 3 479 8256，或电子邮箱：gary.witte@otago.ac.nz）。您提出的任何问题都将会被严格保密并仔细调查，并将及时通知您调查结果。

Appendix J – The questionnaire for the manipulated interpretive signage within the XNWP (Chapter 6)

Section A: Demographic and background information					
Your age	□ 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55 or over □ I would rather not say				
Your gender	□ Male □ Female □ Other □ I would rather not say				
Your highest education level	□ High school or lower level □ Graduate Diploma □ Bachelor □ Master □ Ph.D. □ I would rather not say				
Interest in birds	□ I am interested in birds and have specific knowledge of birds. (bird enthusiasts, bird watchers or biologists/conservationist, including students of the relevant majors). □ I am generally interested in birds, but do not have much experience and specific knowledge of birds (i.e. identification/habits/ecology/conservation, etc.). □ I am not interested in birds.				
Section B: Questions based on the manipulated signage					
Item	Strongly Agree	Somewhat Agree	Neither agree nor disagree	Somewhat Agree	Strongly Disagree
I enjoy reading this sign.					
The interpretive text information on this sign is attractive.					
The image used on the sign is appealing.					
I feel better informed by reading this sign.					
The material increases my interest in the topic (i.e. birds).					
I will share the scientific stories/facts I learned from this sign with friends/family.					
I have known most of the scientific matters interpreted by the sign already before reading.					
I am clear about the meanings of the ornithological concepts referred in the text on this sign					
The image on this sign can help me understand the text information better					
If the researcher did not ask me to read the interpretive sign and complete this questionnaire, I would still like to stop to read it					

Section C: Knowledge test	
Where does a Common Kingfisher usually live?	☐ Forest ☐ Wetland ☐ Farmland ☐ I do not know.
Can a Common Kingfisher survive in the winter of north China	☐ Yes, but only if there is open water on frozen rivers and lakes. ☐ Yes, if the water is frozen they can find food in farmlands. ☐ No, all of them will migrate south because it is too cold. ☐ I do not know.
A Common Kingfisher has an orange lower bill. Is it a male or a female?	☐ Male ☐ Female ☐ I do not know.
What is the colour of feathers on the throat of a Common Kingfisher?	☐ White ☐ Orange ☐ Blue ☐ I do not know.
What is the colour of feathers on the belly of a Common Kingfisher?	☐ White ☐ Orange ☐ Blue ☐ I do not know.
What is the courtship behaviour of a male Common Kingfisher?	☐ Males show colourful plumage to females. ☐ Males sing to females. ☐ Males bring fish as a gift to females. ☐ I do not know.
Where does a Common Kingfisher build a nest?	☐ In the tree holes ☐ In the holes in the riverbank ☐ In the reed field ☐ I do not know.
What is the colour on the feet of a Common Kingfisher?	☐ Grey ☐ Red ☐ Black ☐ I do not know.

Questionnaire for Chapter 6 (Chinese version)

第一部分：背景信息	
您的年龄？	☐ 18-24 岁 ☐ 25-34 岁 ☐ 35-44 岁 ☐ 45-54 岁 ☐ 55 岁或以上 ☐ 我不想透露我的年龄段
您的性别？	☐ 男 ☐ 女 ☐ 其他 ☐ 我不希望透露
您的受教育程度？	☐ 高中或高中以下 ☐ 大学专科 ☐ 大学本科 ☐ 硕士 ☐ 博士 ☐ 我不希望透露
您对鸟类的兴趣	□ 我对鸟有兴趣，并且有一定的知识储备和相关经验（如观鸟爱好者、鸟类学工作者或相关专业的学生/从业者） □ 我对鸟有兴趣，但并没有什么相关的知识储备和经验 □ 我对鸟没有什么兴趣

第二部分：基于您面前这块科普解说牌的问题

项目	完全同意	基本同意	不一定/ 不确定	不太同意	完全 不同意
我很享受阅读这块科普解说牌的过程					
这块科普解说牌上的文字部分很有吸引力					
这块科普解说牌上的鸟类照片很有吸引力					
这块科普解说牌让我增长了知识.					
这块科普解说牌上的内容让我对鸟类更有兴趣了					
我会把这块科普解说牌上的内容分享给我的朋友、家人					
在阅读这块科普解说牌之前，我已经了解了其上介绍的大部分知识					
总体而言，我比较熟悉这块科普解说牌上提及的鸟类学名词的含义					
这块科普解说牌上的照片能让我更容易地理解文字信息					
即使我并未被邀请参与这项调查，看到这块科普解说牌时我也会主动停下来阅读它					

第三部分：知识测验	
普通翠鸟平时生活在哪里？	☐ 森林 ☐ 湿地 ☐ 田野 ☐ 我不知道
冬季，普通翠鸟能在北方生存吗？	☐ 能。但是必须有没有封冻的水域 ☐ 能。因为即使水面都封冻了，它们也能从田里找吃的

	☐ 不能。它们在冬季都会往南迁徙，因为北方太冷了 ☐ 我不知道
有一只普通翠鸟，它的下嘴是橙红色的，它的性别是？	☐ 公鸟　　☐ 母鸟　　☐ 我不知道
普通翠鸟的喉部是什么颜色的？	☐ 白色　☐ 橙色　☐ 蓝色　☐ 我不知道
普通翠鸟的腹部是什么颜色的？	☐ 白色　☐ 橙色　☐ 蓝色　☐ 我不知道
翠鸟求偶的主要方式是以下哪种？	☐ 公鸟给母鸟展示他漂亮的羽毛 ☐ 公鸟给母鸟唱歌 ☐ 公鸟给母鸟送鱼 ☐ 我不知道
普通翠鸟在哪里筑巢？	☐ 树洞里　☐ 河岸的土洞里 ☐ 芦苇丛里　☐ 我不知道
普通翠鸟的脚是什么颜色的？	☐ 灰色　☐ 红色　☐ 黑色　☐ 我不知道

Appendix K – Ethics approval for the WeChat section (online study in Chapter 7)

D18/228

Academic Services
Manager, Academic Committees, Mr Gary Witte

6 July 2018

Professor L Davis
Centre for Science Communication
133 Union St East

Dear Professor Davis,

I am writing to confirm for you the status of your proposal entitled "**The use and role of photography for science communication through WeChat public accounts**", which was originally received on June 29, 2018. The Human Ethics Committee's reference number for this proposal is **D18/228**.

The above application was Category B and had therefore been considered within the Department or School. The outcome was subsequently reviewed by the University of Otago Human Ethics Committee. The outcome of that consideration was that the proposal was approved.

Approval is for up to three years from the date of HOD approval. If this project has not been completed within three years of this date, re-approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

Appendix L – Information sheet for participants in the WeChat section

Visual Appeal:

How the Characteristics of Photographs Can Affect Science Communication in Chinese National Parks

Chapter 7: Factors of WeChat Public Account Articles that Affect Communicating Natural Science Stories

Information Sheet for Participants

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you, and we thank you for considering our request.

What is the Aim of the Project?

How the use of photographs in popular science articles on WeChat Public Accounts influence audience's reading experience.

What will Participants be Asked to Do?

All WeChat users are appropriate participants of this online survey. Should you agree to take part in this project, you will complete an online questionnaire based on your experience and preference of using WeChat Public Account. You will spend about eight minutes this.

What Data or Information will be Collected and What Use will be Made of It?

The data in relation to the participants' habits and preferences of the use of WeChat Public Account will be collected online. Personal information will not be collected. The physical and online data will be securely kept for five years. The results of the project may be published and will be available in the University of Otago Library, but every attempt will be made to preserve your anonymity. You may withdraw from participation in the project at any time before the final point of this research in 2019 without any disadvantage to yourself.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:

Lei Zhu
Centre for Science Communication
University Telephone Number:
N/A
Email: zhule786@student.otago.ac.nz

or

Lloyd Spencer Davis
Centre for Science Communication
University Telephone Number:
+64 21 617 176
Email: lloyd.davis@otago.ac.nz

This study has been approved by the Department stated above (ID: D18/228). However, if you have any concerns about the ethical conduct of the research you may contact the University of Otago Human Ethics Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Information sheet for participants in the WeChat section (Chinese version)

自然科普类微信公众号图文阅读体验调研

您好！我是朱雷，是来自新西兰奥塔哥大学（University of Otago）科学传播学系的一名博士生，此线上问卷调查是我博士研究的一部分。本项研究的目的是探索影响微信自然科普图文传播效果的因素。作为受访者，您的年龄需在 18 岁及以上。在问卷结束之前，您也有权在任何时候选择退出，同时不会有任何损失。问卷填写约需 5-8 分钟，题目全部为选择题。

项目数据的唯一来源是您填写的调查问卷，在此过程中不会进行任何与您相关的影像或视频记录。所有的调查问卷都是匿名的。因此，在填写调查问卷时，您无需填写个人信息。调查数据不会被用于任何商业用途。

调查结束后，原始数据将会被新西兰奥塔哥大学科学传播学研究中心封存，仅本项目作者（包括博士生作者朱雷和导师劳埃德·斯宾塞·戴维斯教授）有权接触。数据电子文档将会被妥善储存在 Office365 的 OneDrive 中。所有原始数据的封存时间为 5 年，之后它们将会被销毁。

如果您希望了解关于本项目的更多信息，欢迎联系：

朱雷	劳埃德·斯宾塞·戴维斯教授
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电子邮箱：zhule786@student.otago.ac.nz	电子邮箱：lloyd.davis@otago.ac.nz

我们非常感谢您的参与；本项目已经被奥塔哥大学学术伦理委员会批准，批准文号为 D18/228。

Appendix M – The questionnaire for the WeChat section (Chapter 7)

Section A: Demographic information and general reading habits, Item 1 to 7	
Your age	□ 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55 or over □ I would rather not say
Your gender	□ Male □ Female □ Other □ I would rather not say
Your highest education level	□ High school or lower level □ Graduate Diploma □ Bachelor □ Master □ Ph.D. □ I would rather not say
Interest in nature	□ I am interested in nature and have specific knowledge of one or more fields (e.g. birds). □ I am generally interested in nature, but do not have much experience and specific knowledge. □ I am not interested in nature.
If you are interested in nature or wildlife, which topic/taxa do you like most?	☐ Mammals ☐ Birds ☐ Reptiles ☐ Amphibians ☐ Plants ☐ Fish and other marine creatures ☐ Terrestrial invertebrates ☐ Other topics in this area ☐ I am not sure/I would rather not say
Have you ever read popular science WeChat articles about nature?	☐ Yes ☐ I have not read this type of article before
What is the appropriate length of a WeChat article about nature for you? (measured by reading time)	☐ Less than 5 minutes ☐ 5 to 10 minutes ☐ 10 to 20 minutes ☐ up to more than 20 minutes ☐ I am not sure/I would rather not say
Section B: How photographs influence the performance of interpretive WeChat articles, Item 8 to 12	
Item 8: What is the most important factor that motivates you to read a popular science WeChat article about nature?	☐ Attractive title ☐ Attractive cover image ☐ The author/public account who has pushed/shared the article. ☐ I am not sure/I would rather not say
Item 9: Choose up to three most important factors that motivate you to give a thumb-up after reading a popular science WeChat article about nature.	☐ Attractive title ☐ In-depth/Useful content ☐ Attractive writing style ☐ Good layout ☐ Appealing photos ☐ Excellent/Unique opinion ☐ Lots of thumb-ups from others ☐ I am not sure/I would rather not say
Item 10: Choose up to three most important factors that motivate you to share a popular science WeChat article about nature.	☐ Attractive title ☐ In-depth/Useful content ☐ Attractive writing style ☐ Good layout ☐ Appealing photos ☐ Excellent/Unique opinion ☐ Lots of shares from others ☐ I am not sure/I would rather not say

Item 11: If you found a WeChat article about nature appeared with appealing photographs, what will you do?	☐ Do nothing, because these appealing photos do not affect my reading experience. ☐ Do nothing, but I will give a thumb-up in mind (moral support only). ☐ Click the "thumb-up" for this article because of these appealing photographs. ☐ Share this article in my WeChat Moments because of these appealing photos.
Item 12: Choose up to three visual aesthetic attributes most negatively affected the appeal of a photograph in WeChat articles about nature.	☐ Colourless subject ☐ Inappropriate composition ☐ Inappropriate exposure ☐ Uncomfortable lighting ☐ Uncomfortable saturation ☐ Poor overall impact ☐ Lack of action/poor narrative ☐ None of the visual attributes above

The questionnaire for the WeChat section (Chinese version)

第一部分：基础信息	
您的年龄？	☐ 18-24 岁 ☐ 25-34 岁 ☐ 35-44 岁 ☐ 45-54 岁 ☐ 55 岁或以上 ☐ 我不想透露我的年龄段
您的性别？	☐ 男 ☐ 女 ☐ 其他 ☐ 我不希望透露
您的受教育程度？	☐ 高中或高中以下 ☐ 大学专科 ☐ 大学本科 ☐ 硕士 ☐ 博士 ☐ 我不希望透露
您是否对自然万物中的一个或多个类群或自然相关话题有兴趣？	□ 我对自然有兴趣，并且有一定的知识储备和相关经验（如观鸟爱好者、生物、保育工作者或相关专业的学生/从业者） □ 我对自然有兴趣，但并没有什么相关的知识储备和经验 □ 我对自然没有什么兴趣
如果您是自然爱好者，请问您对何种类群最感兴趣？	☐ 哺乳动物 ☐ 鸟类 ☐ 爬行动物 ☐ 两栖动物 ☐ 植物 ☐ 鱼或其它水生生物 ☐ 陆生无脊椎动物 ☐ 其他类群或领域 ☐ 我不知道/我不希望透露
您是否阅读过自然科普类微信图文？	☐ 是的 ☐ 没读过
在您看来，一篇自然科普类微信图文的适宜长度是？	☐ 阅读时间在 5 分钟以内 ☐ 阅读时间在 5-10 分钟 ☐阅读时间在 10-20 分钟 ☐ 阅读时间在 20 分钟以上 ☐ 我不知道/我不希望透露
第二部分：影响微信公众号阅读意愿和阅读反馈的潜在因素	
在“订阅号消息”界面，吸引您阅读一篇自然科普类微信图文最重要的因素是？	☐ 有吸引力的标题 ☐ 有吸引力的封面图 ☐ 有吸引力的作者/公众号/分享者 ☐ 我不知道/我不希望透露
请选择 3 项最能促使您给一篇自然科普微信图文点赞的理由。	☐ 有吸引力的标题 ☐ 有用或有深度的内容 ☐ 有吸引力的写作风格 ☐ 优秀的图文排版 ☐ 有吸引力的插图照片 ☐ 内容包含我强烈认同/反对的观点 ☐ 和同类图文相比，这篇图文的点赞量很高 ☐ 其它因素
请选择 3 项最能促使您分享一篇自然科普微信图文的理由。	☐ 有吸引力的标题 ☐ 有用或有深度的内容 ☐ 有吸引力的写作风格 ☐ 优秀的图文排版 ☐ 有吸引力的插图照片 ☐ 内容包含我强烈认同/反对的观点 ☐ 和同类图文相比，这篇图文有很多人分享 ☐ 其它因素
如果一篇自然类微信科普图文中，插图照片都拍得很漂亮，您会？	☐ 内心毫无波动，照片插图的质量并不太影响我的阅读体验 ☐ 默默地在心里点个赞 ☐ 在图文右下角手动点赞 ☐ 因为这些美图而在朋友圈或微信群分享图文
在您阅读自然科普类微信图文时，哪些照片插图最影响您的阅读体验？	☐ 缺乏色彩的主体 ☐ 构图不好 ☐ 曝光不正确/令人不舒适 ☐ 令人不舒适的光线 ☐ 令人不舒适的饱和度 ☐ 缺乏视觉冲击力 ☐ 缺乏动感/故事性 ☐ 以上插图美学属性皆不会影响阅读体验